Norman T. Allen
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MARINE SCIENCE

HEARINGS

BEFORE THE

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE UNITED STATES SENATE

EIGHTY-SEVENTH CONGRESS

FIRST SESSION

ON

S. 901 and S. 1189

BILLS TO ADVANCE THE MARINE SCIENCES

MARCH 15, 16, 17, AND MAY 2, 1961

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CONTENTS

S. 901

Statement of—

Page
Brooding, Dr. Milton E., National Canners Association, Washington, D.C. 131
Chapman, Dr. Wilbert M., director, Resources Committee, San Diego, Calif. 33
Connally, Hon. John B., Secretary of the Navy, Navy Department, Washington, D.C. 71
Donaldson, Dr. Lauren R., professor of fisheries, director, laboratory of radiation biology, University of Washington, Seattle, Wash. 126
Ewing, Dr. Maurice, director, Lamont Geological Observatory, Columbia University, Palisades, N.Y. 95
Fernald, Dr. R. L., director, Friday Harbor Laboratories, University of Washington, Friday Harbor, Wash. 72
Fish, Dr. C. J., director, Narragansett Marine Laboratory, University of Rhode Island, Kingston, R.I. 91
Fleming, Dr. Richard H., professor of oceanography and executive officer of the department of oceanography, University of Washington, Seattle, Wash. 145
Henerson, Dr. Joseph E., director, applied physics laboratory, University of Washington, Seattle, Wash. 117
Idyll, Dr. C. P., head of fisheries research, marine laboratory, University of Miami, Miami, Fla. 24
McLaughlin, Dr. John J. A., Haskins Laboratories, New York, N.Y. 140
Pritchard, Dr. Donald W., director, Chesapeake Bay Institute, chairman, department of oceanography, the Johns Hopkins University, Baltimore, Md. 18
Ray, Dr. Dixy Lee, associate professor, University of Washington, special consultant in biological oceanography, National Science Foundation, Washington, D.C. 134
Reid, J. L., physical oceanographer, Texas Agricultural and Mechanical College, College Station, Tex. 112
Revelle, Dr. Roger, director, Scripps Institution of Oceanography, La Jolla, Calif. 77
Schaefer, Dr. Milner B., Inter-American Tropical Tuna Commission, La Jolla, Calif. 99
Snodgrass, James, member, special committee on oceanographic instrumentation, Scripps Institution of Oceanography, La Jolla, Calif. 101
Vine, Dr. Allyn C., chairman, Oceanography Committee Panel on New Devices for Exploring the Ocean, Woods Hole Oceanographic Institution, Woods Hole, Mass. 122

Statements submitted by—

Allen, Mary Belle, Ph.D., director, laboratory of comparative biology, Kaiser Foundation Research Institute, Richmond, Calif. 167
Burkholder, Paul R., Ph.D., director of research, Kitchawan Research Laboratory, Brooklyn Botanic Garden, R.F.D. No. 1, Ossining, N.Y. 165
Burt, Wayne V., Ph.D., chairman, department of oceanography, Oregon State College, Corvallis, Oreg. 157
College of Fisheries, faculty of, University of Washington, Seattle, Wash. 160
Hargis, William J., Jr., Ph.D., director, Virginia Fisheries Laboratory, Department of Marine Science, College of William and Mary, Gloucester Point, Va. 153
Helfrick, Philip, Ph. D., acting director, Hawaii Marine Laboratory, University of Hawaii, Honolulu, Hawaii 156

Statement submitted by—Continued

Page
Horn, Francis H., Ph. D., president, University of Rhode Island, Kingston, R.I. 171
Leipper, Dale F., Ph. D., department of oceanography and meteorology, Agricultural and Mechanical College of Texas, College Station, Tex 165
Noblin, James E., Jr., director of economic research, Mississippi Industrial & Technological Research Commission, Jackson, Miss 168
Oppenheimer, Carl H., Ph. D., marine microbiologist, Institute of Marine Science, Port Aransas, Tex 162
Sobatka, Harry, Ph. D., director, department of chemistry, the Mount Sinai Hospital, New York, N.Y 159
Saunders, Paul R., Ph. D., professor of pharmacology, University of Southern California, Los Angeles, Calif 166
Smith, F. G. Walton, director, the Marine Laboratory, University ofMiami, Virginia Key, Miami, Fla 23
Szent-Gyorgyi, Albert, M.D., Ph. D., Laboratory of the Institute for Muscle Research, Marine Biological Laboratory, Woods Hole, Mass 167

Letters, telegrams, etc.:

Banner, Albert H., Professor of Zoology, USIS, San Francisco, Calif 186
Barthold, Aubin R., president, Association of Pacific Fisheries, Seattle, Wash 172
Berman, Alan, associate director, Hudson Laboratories, Dobbs Ferry, N.Y 176
Burkholder, Paul R., Ph. D., director of research, Kitchawan Research Laboratory, Brooklyn Botanic Garden, Ossining, N.Y 164
Chandler, David C., Ph. D., director, Great Lakes Research Division, the University of Michigan, Institute of Science & Technology, Ann Arbor, Mich 182
Elliott, F. E., Ph. D., Advanced Undersea Warfare Engineering Defense Electronics Division, Ithaca, N.Y 173
Fye, Paul M., Ph. D., director, Woods Hole Oceanographic Institution, Woods Hole, Mass 154
Hahn, K. Robert, executive vice president, Lear, Inc., Santa Monica, Calif 173
Hargis, William J., Jr., director, Virginia Fisheries Laboratory, Gloucester Point, Va 183
Hart, Hon. Philip A., a U.S. Senator from the State of Michigan, Senate Office Building, Washington, D.C 181
Hasler, Arthur D., Ph. D., chairman, XV International Congress of Limnology in United States, 1962, University of Wisconsin, Madison, Wis 187
Heydecker, Wayne D., secretary-treasurer, Atlantic States Marine Fisheries Commission, Mount Vernon, N.Y 178
Kennedy, Hon. John F., President of the United States, the White House, Washington, D.C 201
Lipp, J. E., corporate director of development planning, Lockheed Aircraft Corp., Burbank, Calif 172
McCarthy, Dr. Joseph L., dean, the graduate school University of Washington, Seattle, Wash 174
McGrath, William H., Ph. D., assistant dean of students, University of Southern California, Los Angeles, Calif 181
Nigrelli, Ross F., director, laboratory of marine biochemistry and ecology, New York Aquarium, Brooklyn, N.Y 177
Plancich, John N., president, Puget Sound Salmon Canners, Inc., Seattle, Wash 172
Ragotzkie, R. A., Ph. D., assistant professor, department of meteorology, University of Wisconsin, Madison, Wis 180
Russell, Findlay E., M.D., director of laboratory, the College of Medical Evangelists, Los Angeles County Hospital, Los Angeles, Calif 185
Sanford, L. R., president, Shipbuilders Council of America, 21 West Street, New York, N.Y 116
Shannon, W. T., director, department of fish and game, State of California, Sacramento, Calif 174
Slifer, G. A., Gibbs Corp., Jacksonville, Fla 171

Letters, telegrams, etc.—Continued

	Page
Snyder, Asa E., Ph. D., director of research, Pratt & Whitney Co., Inc., Newington, Conn	185
Talbot, G. B., Post Office Box 119, Beaufort, N.C	180
Timme, Richard C., National Marine Consultants, Inc., Santa Barbara, Calif	184
Trama, Francesco B., assistant professor, Rutgers, the State University, New Brunswick, N.J	176
Wilber, Charles G., Ph. D., Chief, Experimental Zoology Branch, Directorate of Medical Research, U.S. Army Chemical Research and Development Laboratories, Army Chemical Center, Md	179
Weimer, Robert J., associate professor, Colorado School of Mines, Golden, Colo	188
Withington, Virginia, supervisor, ASW–USW Res., Sikorsky Aircraft, Division of United Aircraft Corp., Stratford, Conn	186
Wood, William R., Ph. D., president, University of Alaska, College, Alaska	171
Agency comments from—	
Atomic Energy Commission, dated May 11, 1961	193
Comptroller General of the United States, dated May 11, 1961	191
Office of Civil and Defense Mobilization, dated April 4, 1961	188
Department of the Interior, dated April 24, 1961	188
National Science Foundation, dated April 27, 1961	189
Department of the Navy, dated May 5, 1961	190
Department of State, dated April 4, 1961	190
Treasury Department, dated April 14, 1961	191

S. 1189

Statement of Hirshfield, Vice Adm. James A., USCG, U.S. Coast Guard Headquarters, Washington, D.C	196
Agency comment from Treasury Department, dated April 14, 1961	201

MARINE SCIENCE

WEDNESDAY, MARCH 15, 1961

U.S. SENATE,
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
Washington, D.C.

The committee met, pursuant to notice, at 11 a.m., in room 5110, New Senate Office Building, Hon. Warren G. Magnuson (chairman of the committee) presiding.

The CHAIRMAN. The committee will come to order.

The committee will now consider S. 901, the marine science and research bill. We have many witnesses who have come from all over the Nation to testify, and we want them to have ample opportunity to be heard on various phases of the bill.

S. 901 is a somewhat broadened version of S. 2692, which was approved unanimously by this committee last year and which passed the Senate without a dissenting voice. All of the departments and agencies designated in S. 2692 to participate in the projected 10-year national oceanographic program are included in the same manner in S. 901.

In the new bill, however, the U.S. Coast Guard has been added. I am sure it can make an important contribution to the overall scientific program.

S. 901 places somewhat more emphasis than did S. 2692 on the medical implications of oceanographic research, scientific instrumentation, utilization of weather ships and other vessels stationed far out in the ocean, and Weather Bureau marine studies. Provisions in S. 2692 for construction of new research and survey ships and new laboratory facilities are retained in S. 901.

S. 901 also proposes a broad education and training program for prospective marine scientists.

Throughout the bill the Great Lakes are on an equality with the oceans. Indeed, from a scientific standpoint, I consider them as an inland ocean, of equal importance to our economy and welfare.

Scientists who have had an opportunity to study S. 901 tell me that it is, in their opinion, a better bill than S. 2692, which the committee approved last year.

Now a word as to need.

Witnesses at today's hearings will tell you of the needs of their particular laboratories or groups.

Witnesses at later hearings will tell you of the needs from the standpoint of national security and welfare.

Considerable emphasis may be placed at this year's hearings on the treasure we gain from the oceans and the Great Lakes—the Nation's fisheries, and on our lag in exploration and research in this area.

In his message on natural resources which was sent to Congress on February 23, it will be recalled that President Kennedy stated that by 1980 this Nation would need an additional 3 billion pounds of fish and shellfish annually to meet its nutrition needs. That is more than a 60-percent increase over our total catch last year of 4,850 million pounds. The latest figures for Soviet Russia are for 1959: 6,799 million, an increase of almost 700 million pounds in 2 years, while our own catch has been declining.

On February 24 I placed in the record a report prepared for me by experts in the executive branch of our Government on the Soviet fisheries threat. It stated categorically that the U.S.S.R. today possesses the world's largest and most modern oceangoing fishing fleet. In tonnage this fleet exceeds ours 5 to 1.

The report showed also that Soviet Russia is operating more fisheries research vessels, more marine laboratories, and is training more marine and fisheries biologists than we are. The Russian fishing fleet off the Newfoundland Grand Banks is now taking 10 times more fish than our own New England fishermen who have fished these grounds for over two centuries. A Soviet fishing fleet is operating in Bering Sea and Russia is sending well-equipped fisheries research vessels deep into the Gulf of Alaska.

Dr. Richard Van Cleve, dean of the College of Fisheries at the University of Washington, is alarmed by these incursions on both sides of the Nation. He writes me a letter, which I will put in the record in full, which states the problem very well.

> It appears that the United States cannot afford to surrender control of the fisheries off its coast to Soviet Russia or to any other country. First, because of the potential direct threat of the presence of large fleets of foreign fishing vessels off our coast; secondly, from the aspect of world production of food.
>
> It seems hardly sensible for the United States to surrender control of marine fisheries to Russia since these marine fisheries can be used by Russia to exert economic or political pressures on these countries which are dependent upon marine fisheries.

One of Soviet Russia's targets now is the west coast of Africa. The committee may hear testimony during these hearings on Soviet fishing activities now underway in the Gulf of Guinea.

The February Commercial Fisheries Review publishes this item from the Soviet Union, and I quote:

> The first of a series of vessels for fishing in the Tropics is now under construction in the East German Baltic port of Straslund. Over 60 have been ordered by the Soviets. Called Tropyk class, they are East German designed, 282.4 feet overall with a beam of 42.6 feet. They will be equipped with refrigerating plant and used mainly for sardine, herring, and tuna fishing.

The United States does not have a single fishing vessel that would meet that criteria.

One interesting comment in the Government report I mentioned above was this:

> Soviet fishing trawlers are in an excellent position for the collection of electronics intelligence.

Fisheries research is only one phase of our oceanographic program. Witnesses here today will touch on many broad and vital aspects. We will try to divide the hearing up for the next 4 or 5 days in certain phases of this whole field of oceanographic research.

(Bills follow:)

[S. 901, 87th Cong., 1st sess.]

A BILL To advance the marine sciences, to establish a comprehensive ten-year program of oceanographic research and surveys, to promote commerce and navigation, to secure the national defense, to expand ocean, coastal, and Great Lakes resources, to authorize the construction of research and survey ships and laboratory facilities, to expedite oceanographic instrumentation, to assure systematic studies of effects of radioactive materials in marine environments, to enhance the public health and general welfare, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SHORT TITLE

SECTION 1. This Act may be cited as the "Marine Sciences and Research Act of 1961".

DECLARATION OF POLICY

SEC. 2. The Congress hereby declares that systematic, scientific studies and surveys of the oceans and ocean floor, the collection, preparation, and dissemination of comprehensive data regarding the physics, biology, chemistry, and geology of the sea, and the education and training of oceanographic scientists through a sustained and effective program is vital to defense against attack from the oceans and to operation of our own surface and subsurface naval forces with maximum efficiency, to the rehabilitation of our commercial fisheries and the increased utilization of these and other ocean resources, to the expansion of commerce and navigation, and to the development of scientific knowledge and understanding of the waters which cover 71 per centum of the earth's surface, life and forces within these waters, and the interchange of energy and matter between the sea and atmosphere.

The Congress further declares that sound national policy requires that the United States not be excelled in the fields of oceanographic research, basic, military, or applied, by any nation which may presently or in the future threaten our general welfare, maritime commerce, security, access to and utilization of ocean fisheries, or contamination of adjacent seas by dumping therein radioactive wastes or other harmful agents.

The Congress further declares that to meet the objectives outlined in the preceding paragraphs of this Act there must be a coordinated, long-range program of oceanographic research and marine surveys similar or identical to that recommended as a minimal program by the Committee on Oceanography of the National Academy of Sciences and National Research Council. The program should include but not be limited to the—

(1) construction of modern, oceangoing ships for scientific research, surveys, fisheries exploration, and marine resources conservation and development;

(2) modernization of existing and construction of new Government and civilian laboratory and shore facilities adequate to service and supplement the research and surveys fleets;

(3) development and acquisition of new and improved research tools, devices, instruments, and techniques which may include but not be limited to bathyscaphs and other manned submersibles, instrumented marine towers and deep ocean buoys, wave gauges, modified icebreakers, acoustical equipment and telemetering devices, current meters, direct density, turbulence and radioactivity measuring devices, biological sampling instruments and equipment, precision salinometers and echo sounders, magnetometers, and deep sea underwater cameras;

(4) recruitment of prospective oceanographers from among undergraduate and graduate students of physics, chemistry, mathematics, biology, engineering, limnology, meteorology, and geology, and the facilitating of their advanced education in the marine sciences by a long-range program, where necessary, of scholarships, fellowships, and research assistantships, supported by or through the National Science Foundation or other appropriate agency of the Federal Government;

(5) improvement of the economic and general welfare by obtaining more adequate information in the fields of marine science concerning the occurrence, behavior, classification, and potential uses of fish, shellfish, and other marine life, and thereby to enhance the development and utilization of living marine resources;

(6) maintenance of a National Oceanographic Data Center to assemble, prepare, and disseminate scientific and technical oceanographic and closely related data, including but not limited to physical, biological, fisheries, hydrographic, bathymetric, meteorological, and climatological data as may be submitted to it by the participating agencies or institutions. All nonclassified data shall be made available for public use; and

(7) development of formal international cooperation in the marine sciences and oceanographic surveys on a reciprocal basis subject to approval by the President. The Congress further declares that a coordinated, long-range program of marine research and surveys requires establishment of a Division of Marine Sciences in the National Science Foundation, the divisional committee of which shall include representation from Government agencies having duties or responsibilities connected with or related to the seas and oceans, and oceanographic scientists associated with universities, laboratories, industries, or foundations, and which Division shall be authorized and directed—

(a) to develop and encourage a continuing national policy and program for the promotion of oceanographic research, surveys, and education in the marine sciences;

(b) to recommend contracts, grants, loans, or other forms of assistance for the development and operation of a comprehensive national program of marine research, oceanographic surveys, and education in the marine sciences;

(c) to cooperate with and encourage the cooperation of the Office of Naval Research, the Bureau of Ships, the Hydrographic Office, the Coast and Geodetic Survey, the Bureau of Commercial Fisheries, the Atomic Energy Commission, the Maritime Administration, the United States Weather Bureau, the United States Coast Guard, the United States Geological Survey, the Public Health Service, the Smithsonian Institution, the National Bureau of Standards, the United States Army Corps of Engineers (including the Beach Erosion Board), the Department of State, and other Government agencies dealing with scientific or collateral problems related to the seas or to the Great Lakes, and the National Academy of Sciences and National Research Council, and administrators and scientists of all universities and institutions receiving assistance from Federal agencies for oceanographic or fisheries research or education in the marine sciences in the form of contracts, loans, grants, leases, donations, scholarships, fellowships, research assistantships, or transfers of funds or property of the Federal Government;

(d) to foster the interchange of information among marine scientists in the United States and foreign nations within the security provisions and limitations of the National Science Foundation Act of 1950 (64 Stat. 171); and

(e) to evaluate the scientific aspects of marine research, surveys, and taxonomy undertaken by agencies of the Federal Government, universities, and institutions receiving assistance from the Federal Government in these scientific and related fields.

NATIONAL SCIENCE FOUNDATION, DIVISION OF MARINE SCIENCES

SEC. 3. (a) Section 7(a) of the National Science Foundation Act of 1950 is hereby amended by striking "and" after the semicolon in (3), redesignating (4) as (5) and inserting immediately after (3) the following new section:

"(4) Division of Marine Sciences; and"

(b) Section 8(b) of the National Science Foundation Act of 1950 is hereby amended by substituting a colon for the period afted "Board" and inserting immediately thereafter the following new proviso: "*Provided*, That the divisional committee of the Division of Marine Sciences shall include among its membership a representative from the Office of Naval Research, the Hydrographic Office, the Coast and Geodetic Survey, the Bureau of Commercial Fisheries, the Atomic Energy Commission, the United States Coast Guard, the Public Health Service, the United States Weather Bureau, the Beach Erosion Board of the United States Corps of Engineers, and at least six scientists selected on a basis of competence from universities and other non-Federal institutions and designated by the National Academy of Sciences and National Research Council to serve on this committee.

SEC. 4. It is necessary in order to further the policies of S. Res. 136, Eighty-sixth Congress, and of this Act, to have the National Science Foundation carry out, under laws, as amended, relating to such Foundation, specified duties as part of the general program for the development of the marine sciences in the United States. Appropriations authorized in this section shall be in addition to other appropriations provided for such Foundation to carry out its duties under law. There is hereby authorized to be appropriated to the National Science Foundation, during the ten-year period beginning with July 1 of the first fiscal year following approval of this Act by the President, the following sums:

(a) The sum of $9,950,000 for the construction of oceanographic research ships;

(b) The sum of $12,440,000 for the operation of oceanographic research ships constructed under the authorizations of this Act;

(c) The sum of $8,250,000 for construction of shore facilities for marine research;

(d) The sum of $37,200,000 for basic marine research operations: *Provided, however*, That the expenditure under this subsection (d) shall not exceed $8,000,000 in any one year of the ten-year program;

(e) Such sums as may be adequate for specialized oceanographic instruments or equipment for marine research and exploration which may include bathyscaphs and other manned submersibles, self-propelled deep sea data collecting vehicles, moored oceangraphic buoy systems, icebreakers and submarines modified for scientific use, acoustic telemetering devices, biochemical sea surface analyzers, direct density measuring devices, hydrophotometers, subsurface cameras and marine geophysical sea floor television systems, seismic equipment, turbulence measuring devices, marine biological devices including oceanographic plankton samplers, precision salinometers, precision echo sounders, oceanographic sound velocity meters, sea floor geothermal probes and geophysical sea floor samplers, audiovisual surveillance systems to monitor sources of marine biological noises, gravimeters, magentometers, marine geophysical remote sensing and recording systems, marine radioactive water samplers and shipboard gamma ray detectors, and other new, improved, or specialized instruments and laboratory equipment: *Provided, however*, That expenditures under this subsection shall not exceed $10,000,000 in any one year of the ten-year program;

(f) The sum of $4,800,000 for education and training in the marine sciences for selected students beginning not lower than the senior level of undergraduate school and continuing through not more than four years of graduate training in such sciences, and for fellowships and research apprenticeships to graduate students and postdoctoral fellows training to become professional physical, biological, chemical, and geological oceanographers: *Provided, however*, That expenditures under this subsection shall not exceed $480,000 per annum.

DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY, BUREAU OF COMMERCIAL FISHERIES, AND BUREAU OF MINES

SEC. 5. The Secretary of the Interior is authorized and directed, with such funds as may be appropriated or otherwise made available to him, to undertake a ten-year program of study and research as part of the general program for the development of the marine sciences in the United States. In furtherance of the purposes of this Act, the Secretary is authorized and directed to carry out, in addition to programs now underway, the following activities:

(a) Make grants of funds to qualified scientists, research laboratories, institutions, or other non-Federal agencies in furtherance of the purposes of this Act, such grants to be used for basic and applied research programs, the purchase of equipment, acquisition or improvement of facilities, and for other uses necessary to carry out the activities and duties hereunder.

(b) Initiate and carry out a program for the replacements, modernization, and enlargement in the number, of oceangoing and Great Lakes ships used for research, exploration, surveying, and the development of marine resources.

(c) Construct and operate a sufficient number of shore facilities and laboratories, including biological, technological, and instrumentation laboratories to support effectively the vessels provided for under the preceding subsection (b), and programs authorized under subsequent provisions of this section wherein laboratory research or development may be useful.

(d) Cooperate with other departments and agencies, including agencies of the several States, in the conduct of ocean surveys from which data relative to the study of ocean resources may be obtained.

(e) Cooperate with other departments and agencies, including agencies of the several States, in the conduct of studies of marine life with relation to radioactive elements, such studies to be directed toward determining the effect of distribution of radioactive elements in the sea on living marine organisms, and other such studies as the Secretary deems necessary to understand and evaluate the relation of radioactivity to the inhabitants of the marine environment.

(f) Conduct studies of the economic and legal aspects of commercial fisheries and the utilization of marine products.

(g) Request and obtain cooperation from and cooperate with other governmental agencies having an interest in the marine sciences, and cooperate with the several States, or their agencies, and with educational institutions, laboratories devoted to fishery research and the marine sciences, industries, and with other public and private organizations and persons who may be of assistance in furthering the conservation, development, and utilization of ocean, estuarine, and Great Lakes resources.

(h) Conduct, wherever necessary to carry out the purposes of this Act, and without regard to previous statutory limitations, examinations, investigations, research, surveys, and mapping of the geological structure, mineral resources, and products in and beneath any accessible portion of the oceans, seas, gulfs, and in or beneath the Great Lakes, and determine, as realistically as possible, the reserves of minerals and metals of industrial, commercial, or monetary value in or beneath these waters, and the effective techniques and probable costs of their recovery and extraction: *Provided, however*, That the authority herein conveyed shall not be construed to supplant, restrict, or change in any way the authority and responsibility of any other department or agency of the United States, including the performance of surveys and mapping.

(i) Encourage and assist in taxonomic studies of marine organisms and in providing facilities for the preservation of specimens useful in scientific classification of marine organisms.

(j) Expand communications facilities and services of the Bureau of Commercial Fisheries to enable transmission, at the discretion of the Secretary, of oceanographic and fisheries data between ships at sea, including United States fishing vessels, research ships operated by Federal or State agencies, institutions, or commercial fisheries organizations, and shore stations operated by or for the Bureau of Commercial Fisheries under contract or otherwise: *Provided, however*, That in transmission of such data there be used radio frequencies presently or subsequently allocated to the Bureau of Commercial Fisheries by the Federal Communications Commission: *Provided, further*, That all oceanographic scientific and fisheries data transmitted under the provisions of this subsection shall be made available to other departments or agencies of the Federal Government, or to the appropriate agencies of such other governments as the Secretary may designate.

(k) Establish with the National Science Foundation a program of education and training in the marine sciences for selected students or employees beginning not lower than the senior level of undergraduate school and continuing through not more than four years of graduate training and research in such sciences.

(l) Take such action and further such other activities as the Secretary finds will accomplish the purposes of this Act.

SEC. 6. It is necessary, in order to further the policies of S. Res. 136, Eighty-sixth Congress, and of this Act, to have the Department of the Interior and its Bureaus and Offices carry out, under laws relating to such Department, specified duties as part of the general program for development of the marine sciences in the United States. Appropriations authorized in this section shall be in addition to other appropriations provided for such Department to carry out its duties under law. There are hereby authorized to be appropriated to the Department of Interior, Bureau of Commercial Fisheries, Bureau of Mines and Geological Survey, during the ten-year period beginning with July 1 of the first fiscal year following approval of this Act by the President, the following sums:

(a) Such sums as are necessary for construction of new fisheries exploration and research ships authorized in subsection (b) of section 5. In the construction of these ships, modern fisheries exploration and research vessels of other nations shall be studied with respect to design and performance with a view to increasing the seaworthiness, range, and efficiency of the United States fisheries research and exploration fleets.

(b) Such sums as are necessary for operation of new fisheries research and exploration ships: *Provided, however,* That operation costs of such new ships placed in operation by the Bureau of Commercial Fisheries shall not aggregate in excess of $3,400,000 per annum, and that, in programing operations of such ships, the Secretary of the Interior shall give full consideration to the needs for such operations in the Atlantic and Pacific Oceans, the Gulf of Mexico, Gulf of Alaska, Bering Sea, other marine areas of present or potential commercial importance, and the Great Lakes.

(c) Such sums as are necessary for capital expenditures in inaugurating, developing, or expanding new ocean resource studies and surveys, including sums for construction or expansion of facilities for such studies, which facilities may include but shall not be limited to, oceanaria, laboratories for research in marine mortality and survival, an institute or institutes for research on diseases of fish, shellfish, and other marine life, unmanned buoys for recording continuous ocean data of value to the fisheries industry, related industries, and other departments and agencies of the Government, mesoscaphs for marine biological observations, and automatic continuous plankton samplers.

(d) Such sums as are necessary for operations, excluding ship operations, of fisheries resource studies including, but not limited to, those stated above in subsection (c) of this section, marine population sampling, biological surveys, ecological mapping, taxonomy, genetics of marine organisms, microbiology, pond fish culture and brackish water fish farming, estuarine studies, marine radiation biology, artificial cultivation of marine organisms and selective breeding of food fishes, closed ecology systems utilizing marine life, migrations, transplantations, and nutrient research: *Provided, however,* That expenditures for operations of new resource studies by the Secretary of the Interior pursuant to this Act not exceed $10,000,000 per annum.

(e) Such sums as are necessary for education and training programs authorized in subsection (k) of section 5 of this Act: *Provided, however,* That costs to the Department of the Interior of education and training under this subsection shall not exceed $100,000 per annum.

(f) The sum of $11,000,000 for continuing studies over a ten-year period of utilization of marine products for human consumption, animal feeds, industrial purposes, fertilizers, and organic chemicals or compounds, for the development of new uses of marine products, for legal and economic studies relating to commercial fisheries, and for investigations of mineral resources in the seas: *Provided, however,* That in directing these studies the Secretary of the Interior shall give full consideration to their being carried on in existing institutions, agencies, or laboratories through the issuance of grants to said institutions, agencies, and laboratories.

(g) The sum of $1,000,000 for operation and maintenance during the ten-year program of expanded oceanographic research and surveys, of the Fisheries Instrumentation Laboratory of the Bureau of Commercial Fisheries, such Laboratory having been established by the Bureau, January 2, 1957, and terminated by the Bureau, December 31, 1960, said Laboratory to resume planning, design and development, for marine biological and fisheries research and exploration, of new and specialized instruments: *Provided, however,* That expenditures for operations of the Fisheries Instrumentation Laboratory by the Bureau of Commercial Fisheries shall not exceed $100,000 per annum: *Provided, further,* That the authority herein conveyed shall not be construed to supplant or restrict the authority of the Secretary of the Interior to contract with qualified instrumentation companies for the planning, design, development, or manufacture of instruments for marine biological research and exploration using such other funds of the Bureau of Commercial Fisheries for this purpose as may be available.

(h) Such sums as are necessary for expanded communications facilities and services authorized in subsection (j) of section 5 of this Act.

(i) All authority of this section of this Act shall be provided for in such manner that all information, uses, products, processes, patents, and other developments resulting from such research or technological advances achieved by Government expenditure will (with such exceptions and limitations, if any, as the Secretary may find to be necessary in the interest of national defense) be available to the general public: *Provided, however,* That nothing contained herein shall be construed as to deprive the owner of any background patent relating thereto to said rights as he may have thereunder.

DEPARTMENT OF COMMERCE

Sec. 7. The Secretary of Commerce is authorized and directed, with such funds as may be appropriated or otherwise made available to him, to undertake a ten-year program of study, surveys, and research as part of the general program for the development of the marine sciences in the United States. In furtherance of the purposes of this Act, the Secretary is authorized and directed to carry out the following activities:

(a) Request and obtain cooperation from other Government agencies having an interest in the marine sciences and ocean surveys, and cooperate with educational institutions, laboratories, and industries devoted to the marine sciences and oceanography, and with other public and private organizations and persons who may be of assistance.

(b) Initiate and carry out a program for the replacement, modernization, and enlargement in the number of oceangoing ships for use in ocean and coastal surveys and research by the Coast and Geodetic Survey.

(c) Construct and operate a sufficient number of Coast and Geodetic Survey shore facilities to support effectively the vessels provided for under the preceding item (b): *Provided further*, That such facilities shall include, but not be limited to, a west coast and east coast operations base for hydrographic and oceanographic ships and for processing data.

(d) Develop, construct, or acquire new or improved techniques, instruments, or equipment for ocean research or exploration which may include but not be limited to automatic data recording and data processing equipment gravimeters, magnetometers, seismic equipment, turbulence measuring devices, precision echo sounders, acoustic telemetering devices and instruments for the study of the current structure of the oceans, oceanic temperatures, bottom topography, sediments, heat flow through the ocean bottom, sound transmission and velocity, ambient noise, biological activity, and specimens and water samples for salinity, phosphate, oxygen, nitrogen, and other chemical or elemental components of the ocean.

(e) The Act of June 12, 1895, as amended (44 U.S.C. 246), is further amended by adding to the Act the following: "*Provided*, That the Secretary of Commerce is authorized to furnish maps, charts and other publications and products of scientific value of the Coast and Geodetic Survey without charge to educational institutions, laboratories, and other public and private organizations and persons when it is determined that to furnish such information is in the national interest."

(f) Inaugurate in the Weather Bureau a comprehensive ten-year study of the interchange of energy and matter between the oceans and the atmosphere and its implications in connection with long-range weather forecasting, the use of infrared radiation thermometers for measurement of sea-surface temperatures in connection with detection of incipient hurricanes, measurements of wave acceleration and pressure, and measurements of solar radiation in the marine environment. The provisions of this subsection may be carried out by means of contacts with public or private organizations, or by grants to scientific institutions carrying on such studies.

(g) Expand studies and investigations by the Weather Bureau of the mechanism by which weather conditions lead to anomalies in ocean surface temperature and the manner in which these anomalies modify the subsequent weather, the basic mechanism of the transfer of momentum from the air to the sea, the relationship of wind velocity over water to that over land, and the extent to which wave pressure, as distinct from wind stress, contributes to the piling up of water against the coasts during hurricanes and other severe storms. The provisions of this subsection may be carried out by means of contracts with public or private organizations, or by grants to scientific institutions carrying on such studies.

(h) Develop, construct, or acquire new and improved instruments, techniques, or equipment for use by the Weather Bureau in studies and investigations authorized under subsections (f) and (g) of this section (7), including but not limited to infrared radiation thermometers, air wind measuring equipment for use on moving vessels, marine automatic meteorological observing stations, and application to such stations of atomic power sources.

(i) Require that the Maritime Administration, when requested by other agencies of the Federal Government, construct, on a reimbursable basis, such oceanographic research ships as may be required by such agencies, including but not limited to ships of approximately five hundred tons and one thousand two hundred to one thousand five hundred tons displacement; design, or arrange for the design of such ships, with due attention given to suitable arrangements of laboratory space and living quarters for scientists, space and power for winches and other auxiliaries, sea keeping and handling qualities at low speeds, quiet operation, efficient and economical scientists-crew ratios, and operation in all kinds of weather; supervise the construction of such ships, undertake research and development for oceanographic research ships of unusual or novel design. Oceanographic research ships constructed pursuant to this subsection shall, when completed, be made available, at the discretion of the Secretary, to nonprofit oceanographic research centers, to other agencies of the Federal Government, or, pursuant to negotiated contracts or grants, to State institutions engaged in oceanographic research requiring oceangoing scientific ships, with preference given to such agencies and institutions which have engaged in such research prior to this Act. The ships authorized by this subsection are in addition to ships authorized to be constructed by other sections of this Act.

(j) Establish with the National Science Foundation a program of education and training in the marine sciences for selected students or employees beginning not lower than the senior level of undergraduate school and continuing through not more than four years of graduate training and research in such sciences.

SEC. 8. It is necessary, in order to further the policies of S. Res. 136, Eighty-six Congress, and of this Act, to have the Department of Commerce and its bureaus and offices carry out, under laws, as amended, relating to such Department or such bureaus and offices, specified duties as part of the general program for the development of the marine sciences in the United States. Appropriations authorized in this section shall be in addition to other appropriations provided for such Department to carry out its duties under law. There are hereby authorized to be appropriated to the Department of Commerce and its bureaus and offices, during the ten-year period beginning with July 1, of the first fiscal year following approval of this Act by the President, the following sums:

(a) Such sums as are necessary for construction by or for the Coast and Geodetic Survey of two survey ships of five hundred tons displacement, two survey ships of one thousand two hundred to one thousand five hundred tons displacement, and four survey ships of two thousand tons displacement or more.

(b) Such sums as are necessary for operations of new Coast and Geodetic Survey ships authorized under this Act during the ten-year life of this program.

(c) Such sums as are necessary for construction of new shore facilities for processing and evaluating Coast and Geodetic Survey oceanographic data, and for construction of an operations base on the west coast of the United States and on the east coast of the United States for hydrographic and oceanographic ships and for processing data.

(d) Such sums as are necessary for engineering and scientific needs for ocean exploration and research conducted by the Coast and Geodetic Survey including but not limited to, wave measuring equipment, systems for reduction of data, manned and unmanned buoys for automatic continuous oceanographic recording, fixed observation stations in coastal waters to determine the short term, seasonal and yearly changes in waves, currents, tides, temperatures, hydrography and salinities in the area surrounding the station, vessel positioning equipment, acoustic equipment and measuring devices for direct density and radioactivity, telemetering devices, current meters, tide gages, underwater cameras and television, seismic equipment, automatic continuous biological sampling devices, precision salinometers, precision echo sounders, towed and fixed temperature recorders, magnetometers, gravimeters, and other instruments and laboratory equipment for oceanographic research.

(e) Such sums as are necessary for operation of shore facilities and operations bases constructed under the authorization provided in subsection (c) of section 7 of this Act.

(f) Such sums as are necessary for the establishment and operation by the Weather Bureau of a ten-year study of the interchange of energy and matter between the oceans and the atmosphere, and for other studies, investigations and research authorized in subsections (f) and (g) of section 7 of this Act.

(g) Such sums as are necessary for development, construction, or acquisition by the Weather Bureau of new and improved instruments, techniques or equipment authorized in subsection (h) of section 7 of this Act.

(h) Such sums as are necessary to enable the Maritime Administration to design and construct the ships authorized in section 7(i) of this Act.

(i) Such sums as may be needed for establishing a program of education and training for selected students and employees, as authorized by subsection (j) of section 7 of this Act: *Provided, however*, That costs to the Department of Commerce of this education and training shall not exceed $100,000 per annum: *Provided further*, That any person who receives training or education under the provisions of this subsection shall agree in writing to continue employment with the Department of Commerce for a period of not less than three years for each year of training received unless separated from the Department sooner for the convenience of the Federal Government.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, OFFICE OF EDUCATION, PUBLIC HEALTH SERVICE

SEC. 9. The Secretary of Health, Education, and Welfare is authorized and directed, with such funds as may be appropriated or otherwise available to him, and the marine sciences; oceanographic, estuarine, inshore and Great Lakes in the United States, to undertake a ten-year program of fellowships and training in or related to the marine sciences; obtaining new faculty in oceanography and the marine sciences; oceanographic, estuarine, inshore nad Great Lakes studies and research related to the public health; and research in medical and pharmacological possibilities and potentials of marine organisms, elements, and substances. In furtherance of the purpose of this Act, the Secretary is authorized and directed to further the following activities:

(a) Award fellowships and develop, through the Office of Education, training programs in oceanography and the marine sciences.

(b) Conduct studies and research relating to the discovery, determination, production, or extraction of medically or pharmacologically important substances from marine organisms or sea water, of parasitism in marine animals, of physiological processes in the marine environment, knowledge of which may contribute to human health, and of substances produced by marine organisms which are toxic to man.

(c) Expand studies of estuarine, inshore, and Great Lakes waters as future major sources for municipal, industrial, and recreational water supplies, of the use of such waters for disposal of municipal and industrial wastes, use of open ocean areas for the disposal of radioactive wastes and of estuarine and inshore ocean waters for the berthing of nuclear-powered ships, and of ocean fishery resources as they relate to the health of the people in the United States, and the health of populations in the underdeveloped countries of the world which are receiving assistance from the United States. The provisions of this subsection, and of the preceding subsection (b), may be carried out by means of contracts with public or private organizations or by grants to scientific institutions carrying on such studies or to qualified scientists engaged in or engaging in marine research or related studies.

(d) Request and obtain cooperation from and cooperate with other governmental agencies having an interest in the marine sciences, and cooperate with the several States, or their agencies, or municipalities, and with educational institutions, medical institutions, laboratories conducting marine, medical, or pharmacological research, and with other public and private associations, organizations, and persons who may be of assistance.

SEC. 10. It is necessary in order to further the policies of S. Res. 136, Eighty-sixth Congress, and of this Act, to have the Office of Education, Public Health Service, Department of Health, Education, and Welfare, carry out, under laws relating to such Department or Office, duties specified in section 9 as part of the general program for the development of the marine sciences in the United States. Appropriations authorized in this section shall be in addition to other appropriations provided for such Department to carry out its duties under law. There is hereby authorized to be appropriated to the Department of Health, Education, and Welfare, during the ten-year period beginning with July 1, of the first fiscal year following approval of this Act by the President, the following sums:

(a) The sum of $5,000,000 to carry out the fellowship and training programs authorized in subsection (a) of section 9 of this Act: *Provided, however*, That expenditures for duties specified in this subsection shall not exceed $500,000 per annum.

(b) Such sums as are necessary to carry out the research and studies authorized in subsection (b) of section 9 of this Act.

(c) Such sums as are necessary to double, within the ten-year period of the national oceanographic program authorized by this Act, research and studies in connection with the programs set forth in subsection (c) of section 9 of this Act.

(d) Research contracted for, sponsored, cosponsored, or authorized under authority of section 9 of this Act, shall be provided for in such a manner that all information, uses, products, processes, patents, and other developments resulting from such research developed by Government expenditure shall be, subject to the national and public health interest as determined by the Secretary and the Surgeon General of the United States, available to the general public: *Provided, however*, That nothing herein shall be construed as to deprive the owner of any background patent relating thereto to such rights as he may have thereunder.

ATOMIC ENERGY COMMISSION

SEC. 11. In furtherance of the policies in S. Res. 136, Eighty-sixth Congress, and of this Act, and for the purpose of determining the effects of radioactive contamination upon the oceans and life within the oceans and their estuaries, inshore ocean waters, and the Great Lakes, and for regulating in the interests of public safety, health, and welfare the introduction of radioactive materials in these waters, the Atomic Energy Commission is hereby authorized to conduct in the marine environment, an intensive ten-year program of control and monitoring of radioactive waste disposal and studies including, but not limited to, circulation and mixing processes which affect the dispersion of introduced contaminants in coastal and estuarine environments, the Great Lakes, and in the open ocean, inorganic transfer of radioactive elements from sea water to sediments, the effect of radioactive elements on living organisms in the oceans, coastal waters, estuaries, and Great Lakes, and the genetic effects of radiation on such organisms. The Atomic Energy Commission is further authorized to carry out any of its duties or functions under this or other Acts, including the use of scientific ships and personnel, in cooperation with other agencies of the Federal Government, or through contracts with or grants to States or State agencies, institutions or independent scientific laboratories undertaking or equipped to undertake such programs: *Provided, however*, That those aspects of the program relating to regulating and monitoring the introduction of radioactive material in the ocean shall be carried out by the Coast and Geodetic Survey or the Public Health Service, or both, with funds made available by the Atomic Energy Commission.

SEC. 12. It is necessary in order to further the policies of S. Res. 136, Eighty-sixth Congress, and of this Act to have the Atomic Energy Commission carry out, under laws relating to such Commission, specified duties as part of the general program for the development of the marine sciences in the United States. Appropriations authorized in this section shall be in addition to other appropriations provided for such Commission to carry out its duties under law. There is hereby authorized to be appropriated by the Atomic Energy Commission, during the ten-year period beginning with July 1 of the first fiscal year following approval of this Act by the President, the following sums as are necessary—

for engineering studies in connection with control and monitoring as authorized in section 11 of this Act: *Provided, however*, That expenditures for this purpose not exceed $370,000 in any one year of the ten-year program authorized by this Act;

for participating in international meetings of scientists and technical experts relating to international control and monitoring of radioactive waste disposal in the marine environment: *Provided, however*, That expenditures for this purpose not exceed $30,000 in any one year of the ten-year program;

for control and monitoring of radioactive waste disposal in coastal and estuarine environments, and in the Great Lakes, as authorized in section 11 of this Act: *Provided, however*, That expenditures for this purpose not exceed $2,800,000 in any one year of the ten-year program of studies by the Atomic Energy Commission in these waters;

for research to determine circulation and mixing processes which control the dispersion of radioactive wastes introduced in deep waters of the open ocean: *Provided, however*, That the expenditures for this purpose by the Atomic Energy Commission not exceed $1,400,000 per annum;

for studies of the inorganic transfer of radioactive elements from sea water to the sediments: *Provided, however*, That expenditures by the Atomic

Energy Commission for this purpose not exceed $485,000 in the first year of the program or $299,000 in subsequent years of this ten-year period;

for studies of the effects of the biosphere on the distribution and circulation of radioisotopes in the ocean, its seas, and the Great Lakes: *Provided, however*, That expenditures by the Atomic Energy Commission for this purpose not exceed $968,000 per annum;

for studies of the genetic effects of atomic radiations on marine organisms: *Provided, however*, That expenditures by the Atomic Energy Commission for this purpose not exceed $100,000 per annum;

for field experiments in confined bodies of water using or utilizing radioisotopes: *Provided, however*, That expenditures by the Atomic Energy Commission for this purpose not exceed $100,000 per annum; and

for two major open-sea tests of radiological contamination at sea, its effects on marine life, and its potential effects on humanity.

DEPARTMENT OF THE NAVY

SEC. 13. In order to further the policies of S. Res. 136, Eighty-sixth Congress, and of this Act, the Secretary of the Navy is authorized and directed to undertake a ten-year program of expanded oceanographic research and hydrographic surveys as part of the general United States program for the development of the marine sciences. The Secretary is authorized and directed, with such funds as may be appropriated or otherwise made available to him for purposes of this Act, to carry out the following activities:

(a) Provide funds, by contract or otherwise, to scientists, Government and non-Government laboratories, or institutions in furtherance of the purposes of this Act, such funds to be used for basic and applied research, the purchase of equipment, acquisition or improvement of facilities, the design, development, and production of specialized, new, and improved oceanographic research, survey, and communications instruments and devices, employment of scientists and personnel, and for other uses necessary to carry out the activities hereunder.

(b) Initiate and carry out a ten-year program for the replacement, modernization and enlargement in the number of ships for use in basic and applied research and hydrographic surveys, and to supply, when available, ships designed for basic research to nonprofit scientific institutions and laboratories: *Provided, however*, That when ships are supplied under this provision, title to the ships shall remain with the United States Government and that the ships shall be reassigned or returned to Federal operation upon termination of the grant of contract with the institution or laboratory.

(c) Construct and operate a sufficient number of shore facilities and laboratories and provide related instruments and equipment to support effectively the expanded program of basic and applied oceanographic research and hydrographic surveys authorized for the Department of the Navy to undertake under this Act.

(d) Develop, construct, or acquire new or improved vehicles and instruments for ocean research and exploration, which may include but not be limited to bathyscaphs, mesoscaphs, self-propelled deep seat data collecting vehicles, and other manned and unmanned submersibles, icebreakers, and submarines converted for scientific use, seismic equipment, turbulence measuring devices, oceanographic sound velocity meters, precision echo sounders, ascoustic telemetering devices, navigation location transponders, audiovisual surveillance systems to monitor sources of biological noises in the ocean, submarine oceanographic plankton samplers, hydrophotometers, fixed coastal acoustical-oceanographic monitoring systems, marine geophysical gravity meters, marine geophysical electron resonance magnetometers, shipboard wave meters and dye detector probes, marine geophysical remote sensing and recording systems, moored oceanic ambient noise monitoring buoys, expendable oceanographic sensor systems, oceanographic sonic and radio frequency marine tags for monitoring marine fishes and mammals, improved midwater trawls, oceanographic shipboard synoptic systems for use on weather ships, radar picket ships and similar vessels assigned to ocean stations and when not underway, marine radioactive water samplers, shipboard gamma ray detectors, marine geophysical underwater cameras, geophysical sea floor television systems, sea floor sediment samplers and analyzers, sea floor dredge winches, and other such instruments, devices and systems as may be useful in studies of the current structure of the ocean, oceanic temperatures, bottom topography, sediments, heat flow through the ocean bottom, sound transmision and velocities, ambient noise, biological activity and specimens, water samples for salinities, phosphates, oxygen, nitrogen, and other chemical or elemental components of the oceans, and for recording and communication of oceanographic data.

(e) Continue and expand the Navy's support of marine studies substantially as proposed in project TENOC approved by the Chief of Naval Operations, or the Navy's revised longrange oceanography program, and substantially similar to recommendations made in the reports of the Committee on Oceanography of the National Academy of Sciences and National Research Council.

(f) Conduct, or facilitate, under such security provisions and conditions as may be prescribed by the Secretary, the conduct of time series oceanographic observations and research from radar picket ships or other suitable vessels,

(g) Establish with the National Science Foundation or the National Academy of Sciences and National Research Council a program of scholarships for selected students beginning at the senior level in undergraduate school, and carrying through with four years of graduate training and research in the marine sciences: *Provided*, That the Department of the Navy may recommend to the National Science Foundation institutions qualified to participate in this program.

(h) Conduct a systematic and expanded program of three-dimensional ocean surveys including measurements or studies of depths, salinity, temperature, current velocity, wave motion, magnetism, and biological activity.

(i) Continue a policy of expanding assistance and support to existing civilian laboratories and universities engaged in basic oceanographic research, foster the establishment and growth of new civilian laboratories for applied oceanographic research needed by the Navy. In the designation of new laboratories to receive Navy assistance, consideration shall be given to geographic location with reference to the oceans, with the object of maintaining a balanced program of research in and adjacent to the seas and oceans bordering the United States.

(j) Request and obtain cooperation from and cooperate with other governmental departments and agencies having an interest in or direct concern with the marine sciences, and to cooperate with the several States, with educational institutions, laboratories, industry, and other private and public organizations and persons who may be of assistance to the Navy in scientific and technological fields.

(k) Section 7394, title 10, United States Code, is hereby amended to read as follows: "The Secretary of the Navy is authorized to furnish maps, charts, and other publications and products of scientific value of the Hydrographic Office without charge to educational institutions, laboratories, and other public and private organizations and persons when it is determined that to furnish such information is in the national interest."

SEC. 14. It is necessary in order to further the policies of S. Res. 136, Eighty-sixth Congress, of this Act, and scientific objectives of the Navy's long-range program for oceanographic research to have the Department of the Navy carry out, under laws relating to such Department, specified duties as part of the general program for the development of the marine sciences in the United States. Appropriations authorized in this section shall be in addition to other appropriations provided for such Department to carry out its duties under law. There is hereby authorized to be appropriated to the Department of the Navy, during the ten-year period beginning with July 1 of the first fiscal year following approval of this Act by the President, such sums as are necessary—

> for the construction of research and survey ships which shall include but not be limited to nine one thousand two hundred to one thousand five hundred tons displacement research ships; four two thousand to three thousand tons displacement research ships; one research ship of three hundred tons displacement; three survey ships of two thousand to three thousand tons displacement; five survey ships of one thousand two hundred to one thousand five hundred tons displacement; two survey ships of approximately five hundred tons displacement;
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> for operations of new (basic) research ships constructed under the authorization of this section (in excess of present operating costs for such ship operations): *Provided, however*, That the operating costs of new one thousand two hundred to one thousand five hundred ton displacement research ships not exceed $420,000 each per annum; that of new two thousand to three thousand ton displacement ships for research or surveys not exceed $700,000 each per annum, and that of new five hundred ton ships not exceed $250,000 each per annum;

for modernization, improvement, and expansion of existing shore facilities for basic research and for construction of new shore facilities for basic research;

for basic research operations other than ships;

for modernization, improvement, and expansion of existing shore facilities for survey work and for construction of new shore facilities for survey work;

for engineering needs and for the development, construction, or acquisition of new or improved vehicles and instruments for ocean or Great Lakes research and exploration which may include, but shall not be limited to, bathyscaphs, mesoscaphs, self-propelled deep sea data collecting vehicles, and other manned and unmanned submersibles, wave measuring equipment, systems engineering for reduction of data, manned and unmanned buoys for automatic continuous oceanographic recording, icebreakers and submarines modified or converted for scientific use, vessel positioning systems, seismic equipment, turbulence measuring devices, oceanographic sound-velocity meters, precision echo sounders, acoustic telemetering devices, navigation location transponders, audio-visual surveillance systems to monitor sources of biological noises in the oceans or in the Great Lakes, submarine oceanographic plankton samplers, hydrophotometers, fixed coastal acoustical-oceanographic monitoring systems, marine geophysical gravity meters, marine geophysical electron resonance magnetometers, shipboard wave meters and dye detector probes, marine remote sensing and recording systems, moored oceanic ambient noise monitoring buoys, expendable oceanographic sensor systems, oceanographic sonic and radio frequency marine tags for monitoring marine fishes and mammals, improved midwater trawls, ocean-shipboard synoptic systems for use on weather ships, radar picket ships, and similar vessels assigned to ocean stations and when not underway, marine radioactive water samplers, shipboard gamma ray detectors, marine geophysical underwater cameras, geophysical sea floor television systems, sea floor sediment samplers and analyzers, sea floor dredge winches, constant tension cable reels, moored oceanographic buoy systems for recording and transmission of important oceanographic and meteorological data in deep ocean areas, marine sea floor geothermal probes for determining heat flow characteristics and values, and other such instruments, devices, and systems as may be useful in studies of the current structure of the oceans, oceanic temperatures, bottom topography, sediments, heat flow through the ocean bottom, sound transmission and velocities, ambient noise, biological activity in the marine environment and specimens, water samples for salinities, phosphates, oxygen, nitrogen, and other chemical or elemental components of the oceans, and for recording and communication of oceanographic data of scientific value.

for time series oceanographic observations and research conducted on and from radar picket ships or other suitable vessels operated by the Navy: *Provided, however*, That equipment costs for such time series oceanographic observations and research conducted on or from such ships not exceed $82,500 per ship during the ten-year program authorized in subsection (f) of section 13 of this Act, and that operations costs of this program not exceed $58,000 per ship per annum in any year of the ten-year program;

for establishing a program of scholarships for selected students and postdoctoral fellowships as authorized in section 13(g) of this Act: *Provided, however*, That costs to the Department of the Navy for these scholarships and fellowships not exceed $300,000 per annum.

DEPARTMENT OF THE ARMY

SEC. 15. The Secretary of the Army is authorized and directed, with such funds as may be appropriated or otherwise made available to him, to undertake a ten-year program of study and research by the United States Army Corps of Engineers, through the Beach Erosion Board, as part of the general program for the development of the marine sciences in the United States. In furtherance of the purposes of this Act, the Secretary is authorized and directed to carry out, in addition to programs now underway, the following activities relating to physical oceanography in the near-shore areas of the Atlantic and Pacific Oceans, the Gulf of Mexico, and the Great Lakes, which areas include the zone from the shore to the fifty-fathom depth contour in the oceans and lakes, and bays and tidewaters connected therewith:

(a) Request and obtain cooperation from other Government agencies having an interest in the marine sciences and ocean surveys, and cooperate with educational institutions and laboratories devoted to the marine sciences and oceanography, and with other public and private organizations and persons who may be of assistance.

(b) Contract with qualified scientists, research laboratories, research organizations, or educational institutions to undertake basic and applied research studies and experiments in the laboratories and in coastal waters, in furtherance of the purposes of this section.

(c) Undertake in coastal waters studies of the action of waves, wave currents, tides, tidal currents, and large-scale ocean littoral currents.

(d) Study and evaluate the interaction of the atmosphere, the sea, and the land as they affect the waves, currents, tides, surges, hydrographic contours, and hydrographic changes in the coastal zone.

(e) Establish observation stations in coastal waters to determine the short-term, seasonal, and yearly changes in waves, currents, and hydrography in the area surrounding the station.

(f) Develop, construct, or acquire instruments and equipment for the furtherance of the program of studies authorized in this section.

(g) Determine the sources of the bottom materials in the coastal area, the rates and methods of movement of these materials, and the effects on the coastal hydrography of changes in the rate at which these materials reach the coastal zone.

(h) Study the mechanics and effects of density currents encountered in the coastal area on the current velocities, current patterns, hydrography, interchange of waters, and rates of sedimentation.

SEC. 16. In order to carry out the policies of this Act and of S. Res. 136, Eighty-sixth Congress and to provide for the participation of the Department of the Army, including either or both military or civil functions activities, in the general program for the development of marine sciences in the United States, there is hereby authorized to be appropriated to the Department of the Army, during the ten-year period beginning July 1 of the first fiscal year following approval of this Act, the following sums, not to exceed $2,000,000 per annum:

(a) Such sums as are necessary for the investigations and activities described in section 15 relating to investigations in physical oceanography in the near-shore zone.

(b) Such sums are necessary to purchase, develop, or acquire and operate the scientific equipment required for investigations in physical oceanography in the near-shore zone, including but not limited to amphibious craft, floating craft, fixed platforms, buoys, current meters, wave meters, tide gages, sound equipment, direct density measuring equipment, turbulence meters, underwater cameras, and underwater television equipment, and other instruments and laboratory equipment for oceanographic research in the near-shore zone.

(c) Such sums as are required for expansion and equipping of shore facilities as are necessary to support the program of investigations in physical oceanography in the near-shore zone.

(d) Such sums as are necessary to provide funds for contracts with qualified scientists, research laboratories, research organizations, or educational institutions to make investigations into physical oceanography in the near-shore zone.

DEPARTMENT OF THE TREASURY, UNITED STATES COAST GUARD

SEC. 17. (a) Title 14 of the United States Code, chapter 1, section 2, is hereby amended by inserting after the clause "and rescue facilities for the promotion of safety on and over the high seas and waters subject to the jurisdiction of the United States;" and before the clause "and shall maintain a state of readiness to function as a specialized service in the Navy in time of war." the following new language: "oceanographic research in and beneath any accessible portions of the oceans, seas, gulf and bays including international waters;"

(b) Title 14 of the United States Code, chapter 5, section 81, is hereby amended by inserting in the first sentence after the word "aircraft" and the comma, the new words: "oceanographic research;" and by inserting after (3) the following new subsection:

"(4) aids to oceanographic research required to serve the needs of maritime commerce and navigation, including undersea navigation, the national defense, and of increasing the safety of life and property on the high seas."; and by inserting in the subsequent paragraph after the words "loran stations" and before the words "shall be established" the following new language: "and scientific instruments, equipment, systems and facilities".

(c) Title 14 of the United States Code, chapter 5, section 90(a), is hereby amended by inserting after the word "communication," and before the words "and air navigation facilities," the following new words: "oceanographic research and surveys".

(d) Title 14 of the United States Code is further amended by inserting at the end of chapter 5 the following new section:

"§ 94. Oceanographic research

"The Coast Guard may conduct such oceanographic research and collect and analyze such oceanographic data, in cooperation with other agencies of the Government or not, as the Secretary determines to be in the national interest: *Provided, however,* That the authority herein conveyed shall not be construed to supplant, restrict, or change in any way the authority and responsibility of any other department or agency of the United States, including the performance of surveys and mapping."

(e) The analysis of chapter 5 of title 14 of the United States Code is amended by inserting at the end thereof the following:

"Sec. 94. Oceanographic research."

(f) As part of the general United States program for the development of the marine sciences, the Secretary of the Treasury is authorized and directed to undertake, through the United States Coast Guard, and without regard to previous statutory limitations, a ten-year program of oceanographic research. The Secretary is authorized and directed, with such funds as may be appropriated or otherwise made available to him for purposes of this Act the following activities:

(1) Request and obtain cooperation from and cooperate with other governmental agencies having an interest in the marine sciences, and, under such provisions and conditions as may be prescribed by the Secretary, cooperate with the several States, with educational institutions, laboratories, and with scientific organizations in programs of oceanographic research.

(2) Conduct, in cooperation with Government agencies, including agencies of friendly governments requesting and reciprocating such cooperation, bathythermograph observations, sonic soundings, strontium 90, carbon 14, air pollution, sea water and plankton samplings, studies of marine borers and fouling organisms, and such other oceanographic research as, in the opinion of the Secretary and the Division of Marine Sciences of the National Science Foundation, will advance the marine sciences in and of the United States.

(3) Expand, in pursuance of functions of the Department under this Act, or in cooperation with other Government agencies and with institutions and scientific organizations, under such provisions and conditions as the Secretary may prescribe, oceanographic research conducted on or from weather ships and other ocean station vessels operated by the United States Coast Guard, offshore towers operated by the Coast Guard, and from such large, oceangoing Coast Guard vessels, including cutters, icebreakers, tugs, patrol craft, lightships and buoy tenders as the Secretary in consultation with other Government agencies and the Division of Marine Sciences of the National Science Foundation may find adaptable to oceanographic research: *Provided, however,* That in this determination, the research to be undertaken shall not diminish the capabilities of the respective classes of Coast Guard vessels, or of their officers or crews, to accomplish their primary missions as assigned to them by the Secretary or the Commandant of the Coast Guard.

(4) Obtain and install on such Coast Guard vessels as the Secretary may designate under subsection (f)(3) of section 17 of this Act, such equipment or instruments as may be acquired for oceanographic research authorized under this section (17).

(5) Provide such facilities or personnel as may be required for analysis of oceanographic data collected and transmitted under the provisions of this section (17).

(6) Encourage and assist selected officers and employees of the Coast Guard to enroll in and pursue formal courses in oceanography, beginning not lower than the senior level of undergraduate school and continuing through not more than four years of graduate training and research in the marine sciences.

SEC. 18. It is necessary in order to further the policies and provisions of this Act to have the Secretary of the Treasury, Department of the Treasury, and the Coast Guard carry out, under laws, as amended, relating to such Department or the Coast Guard, specified duties as part of the general program for the development of the marine sciences in the United States. Appropriations authorized in this section shall be in addition to other appropriations provided for such Department to carry out its duties under law. There is hereby authorized to be appropriated to the Department of the Treasury and the Coast Guard, during the ten-year period beginning with July 1, of the first fiscal year following approval of this Act by the President, the following sums:

(a) Such funds as are necessary to carry out the duties, functions, and operations on Coast Guard vessels and offshore towers authorized in subsection (f) (3) of section 17 of this Act.

(b) Such sums as are necessary for equipment and instruments authorized in subsection (f) (4) of section 17 of this Act: *Provided, however*, That instruments and equipment costs for Coast Guard vessels and offshore towers selected to participate in Coast Guard oceanographic research programs not exceed $82,500 per ship or tower during the ten-year program authorized in subsection (f) of section 17 of this Act.

(c) Such sums as are necessary for analysis of oceanographic data of value collected and transmitted under the authorization of subsection (f) (5) of section 17 of this Act.

(d) Such sums as are necessary for education and training authorized in subsection (f) (6) of section 17 of this Act.

SMITHSONIAN INSTITUTION, MUSEUM OF NATURAL HISTORY

SEC. 19. In furtherance of the policies in S. Res. 136, Eighty-sixth Congress, and of this Act, and in order to preserve, study and classify marine, coastal, and Great Lakes organisms collected during a ten-year program of expanded hydrobiological research, the Secretary of the Smithsonian Institution is authorized and directed, with such funds as may be appropriated or otherwise made available to him, to—

(a) construct additional facilities for the purposes authorized in this section;

(b) establish a program for the recruitment, training, and placement of taxonomists in such number as may be required to classify fishes, marine invertebrates, and other marine organisms collected during the ten-year program of expanded hydrobiological research;

(c) make grants of funds to qualified scientists, institutions, laboratories, or museums, such grants to be used for taxonomy relating to marine organisms;

(d) request and obtain cooperation from and cooperate with other governmental departments and agencies having a direct interest in the preservation, study, and classification of marine organisms, and to cooperate with the several States, educational institutions, laboratories, museums, and other public and private organizations and persons who may be of assistance in this field of marine science.

SEC. 20. It is necessary in order to further the policies of S. Res. 136, Eighty-sixth Congress, and of this Act to have the Smithsonian Institution carry out, under laws relating to such Institution, specified duties as part of the general program for the development of the marine sciences in the United States. Appropriations provided in this section shall be in addition to other appropriations provided for such Institution to carry out its duties under law. There is hereby authorized to be appropriated to the Smithsonian Institution, during the ten-year period beginning with July 1 of the first fiscal year following approval of this Act by the President, the following sums:

(a) Such sums as may be necessary for the construction by the Smithsonian Institution of facilities necessary to preserve, study, and classify for taxonomic purposes marine, coastal, and Great Lakes organisms collected by or for the Institution during the ten-year program of expanded hydrobiological research.

(b) Such sums as are necessary for establishment by the Institution of a program for the recruitment, training, and placement of taxonomists required for the purposes of this section.

(c) Such sums as are necessary for use by the Institution under the authority of section 19 (c).

(d) Such sums as are necessary for the preservation, study, and classification by the Institution of fishes and marine invertebrates collected or acquired by the Institution for taxonomic purposes.

GENERAL

Sec. 21. (a) Nothing in this Act shall operate to limit, restrict, or otherwise interfere with carrying out any work programed prior to enactment of this Act.

(b) All appropriations authorized in this Act shall be in addition to other appropriations provided for the various departments, agencies, bureaus, and offices to carry out their duties under law.

(c) All agreements for grants executed pursuant to the authoirity contained in this Act in excess of $50,000 shall contain a provision that the Comptroller General of the United States or his duly authorized representatives shall have the right to examine any directly pertinent books, documents, papers, and records of the grantee relating to the purpose of the grant for a period of three years after the last payment to the grantee under the grant.

(d) Secretaries of departments, and administrators of bureaus or offices authorized and directed to carry out provisions of this Act, shall, after approval of this Act by the President, include in their annual reports a report on major activities or programs undertaken under the provisions of this Act.

(e) All ships and surface or subsurface craft constructed pursuant to the authorizations for appropriations contained in this Act shall be constructed in domestic commercial facilities.

[S. 1189, 87th Cong., 1st sess.]

A BILL To amend title 14 of the United States Code in order to authorize the Coast Guard to carry on certain oceanographic research

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That title 14 of the United States Code, relating to the Coast Guard, is amended by inserting at the end of chapter 5 the following new section:

"§ 94. Oceanographic research

"The Coast Guard may conduct such oceanographic research, use such equipment or instruments, and collect and analyze such oceanographic data, in cooperation with other agencies of the Government or not, as the Secretary determines to be in the national interest."

Sec. 2. The analysis of chapter 5 of title 14 of the United States Code is amended by inserting at the end thereof the following:

"94. Oceanographic research."

The Chairman. Our first witness is Dr. Donald W. Pritchard, director of the Chesapeake Bay Institute and chairman of the department of oceanography of the Johns Hopkins University. Because he has to hurry back on an important mission, I will ask him to testify first.

STATEMENT OF DR. DONALD W. PRITCHARD, DIRECTOR, CHESAPEAKE BAY INSTITUTE; CHAIRMAN, DEPARTMENT OF OCEANOGRAPHY, THE JOHNS HOPKINS UNIVERSITY, BALTIMORE, MD.

Dr. Pritchard. Thank you very much.

I am Donald W. Pritchard, director of the Chesapeake Bay Institute and chairman of the department of oceanography, the Johns Hopkins University, Baltimore, Md.

I would like to express my appreciation to the chairman of your committee, Senator Magnuson, to Senator Butler, the member of your committee from my State, and to the other committee members for this opportunity to comment on Senate bill S. 901, the "Marine Sciences and Research Act of 1961," and to discuss the need for a national oceanographic program.

I am testifying before you today as director of an oceanographic research institution aand as chairman of a graduate department of oceanography in a privately endowed university.

The CHAIRMAN. I don't like to interrupt, but it points up what you are saying. As chairman of the graduate department of oceanography at Johns Hopkins, you indicate another serious need for this. Do you give a degree in regular college work in oceanography?

Dr. PRITCHARD. We give a graduate degree in oceanography.

The CHAIRMAN. Graduate?

Dr. PRITCHARD. Yes, sir, a master's degree and a doctorate degree in oceanography.

The CHAIRMAN. There are very few institutions, are there not, which give this degree? In other words, we are lacking in this, are we not?

Dr. PRITCHARD. That is right.

The CHAIRMAN. What other institutions do give graduate degrees in oceanography?

Dr. PRITCHARD. The University of Washington, Oregon State University, the Scripps Institution of Oceanography, the University of Southern California is now developing a program to do this, Texas A. & M.

The CHAIRMAN. And Miami?

Dr. PRITCHARD. The University of Miami. The State University in Florida also has a program, though they do not give a degree in oceanography; they give work equivalent to a degree in oceanography in other departments.

The CHAIRMAN. The point I am making is that all of these things are just starting?

Dr. PRITCHARD. That is right.

The CHAIRMAN. We are new in this field?

Dr. PRITCHARD. Yes, sir. I will try to bring that out.

The CHAIRMAN. Go ahead.

Dr. PRITCHARD. Representatives of the National Academy of Sciences' Committee on Oceanography as well as others will undoubtedly testify before you as to the overall national needs in the field of oceanography. I feel I can best serve your committee by presenting certain information regarding my own institution, since other people will testify as to the overall need of oceanography.

I do this since I feel that the specific problems of mounting an adequate research program in the field of oceanography as encountered at my own institution are fairly typical of the problems encountered at most of the private oceanographic institutions in the country.

There is a very close tie between the research activities in the field of oceanography and the graduate training program in that same field at the Johns Hopkins University. Because of this we have been able to maintain a highly qualified joint research and teaching staff capable of providing graduate training to many more students than have been or are now in residence. The need for a rapid and significant increase in the number of students undergoing graduate training in the field of oceanography is amply brought out in the reports of the Committee on Oceanography of the National Academy of Sciences as well as the report entitled "Education and Recruitment of Oceanographers in the United States" recently published by the American Society of Limnology and Oceanography. As a result of the increased public awareness of the field of oceanography educational activities such as my own are receiving a greatly increased number of applications for graduate training in the field.

Concurrent with the increase in the number of applications is a marked increase in the caliber of the applicants. The number of graduate students that we have in residence at one time is, however, critically limited by the amount of available shore facilities. Our present academic staff could provide excellent graduate training and graduate research supervision to at least 30 students. Our present enrollment of 10 is very close to the maximum number of students we can have without seriously affecting the caliber of training, because of the lack of adequate graduate research facilities. We will be able to admit only one out of every two otherwise acceptable students next year because of the lack of adequate space for graduate study and research.

This lack of adequate shore facilities is also affecting the further development of our research activities in the field of oceanography. At the present time the department of oceanography and the Chesapeake Bay Institute have 30 full-time and 10 part-time personnel employed in our campus facilities—that is exclusive of our ship operation.

In the summertime the 10 part-time personnel are employed full-time, and we normally add from 3 to 5 additional technician-grade people. The present staff includes 10 senior and associate staff engaged in teaching and research, 14 research assistants, and 12 technician-grade and administrative personnel, for a total of 40. These people occupy a total of 1,787 square feet of office space, 2,050 square feet of chemistry and biological laboratory space, 410 square feet of electronics laboratory and shop space, and 255 square feet in our computer room, photo laboratory and draftsman space. Twenty-seven of our personnel occupy the office space for an average of 66 square feet per man. Of the 11 who use the biology and chemistry laboratory, only 3 have separate office space, and the remainder must use valuable laboratory space for desk space. None of the five electronics and instrument personnel have office space outside the electronics laboratory.

Our present chemistry and biology laboratory space is less than one-third the 6,150 square feet of such space which is required for the program we are now capable of pursuing. We have no laboratory space which can be utilized for graduate student research. Preparation and analysis of oceanographic data requires much more office space than for other types of office activity because of the necessity of having large plotting tables for current work and readily available storage facilities for raw data and for the graphs, plotting sheets, et cetera, used in the various stages of data reduction and analysis. Again our present office space represents only about one-third of our requirement for this type of space.

The use of machines for data processing, analysis, and computations is playing an ever-increasing role in oceanography. Certain types of problems now being pursued involve such rapid accumulation of data that machine treatment is an absolute requirement. While complete computer facilities need not be located within an oceanographic shore facility, auxiliary equipment used to prepare data for use in high-speed computers is required. The space we now have for such auxiliary data preparation equipment is not sufficient, and we require about twice our present space for this purpose.

Besides the fact that our present space is insufficient as to amount, it is also in certain critical instances inefficiently arranged. Thus, in order to obtain an electronics laboratory, we converted what had been a wide corridor connecting two parts of our facility. We gained 330 square feet of usable space this way; however, in order to go from the area containing our senior staff offices and administrative office to the area containing our data reduction facilities plus several associate staff offices and a small chemical laboratory, it is necessary to either go through the rather narrow electronic laboratory and disrupt work in progress there or to take a very long circuit which involves descent to the basement of the building and return to the first floor where our facilities are located.

As a further move to gain space, we have resorted to constructing balconies in some rooms which have high ceilings, these balconies being used to store reference material and for file cabinets, et cetera. These balconies, while useful, do not quite have adequate headroom and hence are somewhat uncomfortable to use.

Our research programs in the areas of estuarine circulation and incipient wind-wave development would be greatly facilitated by utilization of small hydraulic models and wave tanks. At present we have no space at all to utilize for this type of experimental oceanography. We could efficiently utilize between 2,000 and 3,000 square feet of open experimental area for limited experimental work using hydraulic models, hydraulic flumes, and wave tanks.

A private institution such as the Johns Hopkins University with the many requirements being placed on it for the adequate education of the Nation's youth simply cannot on its own meet the increased facilities requirements in the field of oceanography. Specific shore-facilities funds must be provided as part of the increased national effort in oceanography. I feel this is the one area where the Committee on Oceanography in its original report grossly underestimated the total funds necessary in order to provide adequate shore facilities to support the proposed 10-year program in oceanography.

In addition to the requirement for more adequate shore facilities, oceanography cannot compete for the top-notch student without adequate student aid through graduate fellowships and scholarships. In most universities oceanography is a relatively new field. Departments of oceanography frequently find themselves at a disadvantage compared to other departments in the university because these older departments normally have some specific endowed fellowships for graduate training in their field.

Last year we accepted 11 applicants for admission as first-year graduate students in oceanography. Only five of these finally matriculated. The remainder went into other fields where they could receive financial support which we could not offer.

I am pleased to note that S. 901 does provide the authority for expenditure of funds by the National Science Foundation for undergraduate and gradute fellowships in the field of oceanography.

Finally, I would like to point out that the major research activity of my own institution is concerned with studies in coastal and estuarine water bodies. These parts of the marine environment are the ones in most intimate contact with man and from which man now harvests his greatest return from the sea. These bodies of water, as for example the great Chesapeake Bay which is part of the territorial waters of the States of Maryland and Virginia, can through increased research activities contribute even more to man's welfare.

In considering the national needs for an increased research program in oceanography, the somewhat more glamorous aspects of deep-sea research should not completely overshadow the requirement for increased activities in coastal and estuarine environments. In this regard there is particular need for small research vessels especially designed for coastal and estuarine research.

I am pleased to note that S. 901 does specifically mention estuarine environments in several places and also now specifically includes authority for increased activity by the U.S. Army Corps of Engineers through the Beach Erosion Board, whose specific area of interest is in inshore and coastal oceanography.

I would again like to thank the committee for this opportunity to testify before them and I am quite willing to answer any questions that Committee members might wish to ask me.

The CHAIRMAN. Doctor, would you say that the general conditions that you are trying to work under at the Institute are somewhat duplicated in other places, from your general information?

Dr. PRITCHARD. Yes, sir. I have been very specific, and I apologize to the committee from that standpoint, in regard to my own institution. I do this to present to you a concrete example, and it is only an example. I do not say that my institution is worse off than others; but it is the situation that exists countrywide.

The CHAIRMAN. Of course, you are pleased with the fact that the bill does provide for increased activity through the Beach Erosion Board on some of the problems that are confronting the coastlines of America?

Dr. PRITCHARD. Yes, sir.

The CHAIRMAN. Because of erosion and other ocean phenomena, even including the hurricanes and storms which have caused so much destruction on the east and gulf coasts.

Dr. PRITCHARD. Yes, sir, that is quite right.

The CHAIRMAN. We thank you very much. We know that you have to get away.

Dr. PRITCHARD. Thank you very much, sir.

The CHAIRMAN. Dr. Idyll, will you come forward? The Senator from Florida is here and I know he would like to hear what you have to say.

Senator SMATHERS. Thank you, Mr. Chairman. I appreciate your bringing the doctor up. I would like to hear him.

The CHAIRMAN. I might say, before the doctor starts, that we have a statement from Dr. Walton Smith, director of the marine laboratory, University of Miami, which we will put in the record.

(The statement follows:)

UNIVERSITY OF MIAMI,
THE MARINE LABORATORY,
Virginia Key, Miami, Fla., March 7, 1961.

Senator WARREN MAGNUSON,
Senate Office Building, Washington, D.C.

DEAR SENATOR MAGNUSON: I regret that prior commitments makes it impossible for me to attend the hearings of your committee but I should like to submit the following statement, inasmuch as, in the opinion of both my colleagues and myself, your bill (S. 901) is an extremely important one.

My name is Frederick George Walton Smith. I was awarded the degree of doctor of philosophy in the University of London, England, in 1934. I also hold the degrees of B. Sc. and A.R.C.S. My entire career has been devoted to research and teaching in biological and physical oceanography. At present I am director of the Institute of Marine Science (The Marine Laboratory) of the University of Miami, which I had the honor of establishing in 1943. Although this laboratory is unique in being the only tropical marine research institution in the United States many of its problems are common to all marine research institutions and may be to a great extent solved by the passage of your bill.

I am also a vice president of the International Oceanographic Foundation. One of the objectives of this foundation is to provide funds from private sources for the support of research and teaching in oceanography. A second function is public education and dissemination of authoritative information regarding oceanography. This it does through its illustrated magazine Sea Frontiers, of which I am editor.

I am sure there is no longer any need to stress the importance of oceanography to the national welfare since this has been well covered by the report of the Committee on Oceanography of the National Academy of Science.

The ocean is our first line of defense. It is clear that a greater scientific understanding of oceanographic phenomena is vital to submarine navigation and to improve submarine attack, defense, and communication.

The role of the oceans as a source of food has not yet become vital in our own country but, with a rapidly growing population both in the United States and throughout the world there must inevitably come a time when food from the sea will be a problem of the first magnitude. It is unthinkable that a country such as ours should be allowed to fall behind other countries in preparing for that day.

What is true of seafood is true of minerals to an even greater degree since the land sources of mineral wealth are not crops but are strictly capital in nature so that once used they have gone forever.

There is hardly an aspect of our science today which is not to a greater or lesser extent dependent upon our knowledge of the sea. An example of this is meteorology. The ocean which absorbs and stores the greater part of the sun's heat falling on this planet and which is the reservoir of our atmospheric moisture is a major part in the weather machine. Prediction and eventually the human control of weather and destructive phenomena such as hurricanes are inescapably dependent upon our improved understanding of the ocean itself.

Those of us who are trying to rescue oceanography from its past neglect are concerned with a shortage of trained scientists and of research ships, buildings, and scientific instruments. At Miami we need a 700-ton vessel and a 1,560-ton vessel properly designed for research. The only seagoing vessel we have at the moment was converted from a private yacht. Nevertheless we have secured the services of first rate marine architects and engineers and have developed an advanced design of twin-hulled research vessel, involving new principles and devices which will do much to modernize seagoing operations. This progress in design will enable a vessel to be built at considerable savings over the cost of a conventional hull, but the funds have not hitherto been available for this much needed development.

Our present buildings including corridors, workshops, and storage have less than 35,000 feet of floor space. The scientific staff, teaching staff, technicians, and students occupying this space need additional classrooms and laboratories to provide approximately 34,000 square feet of extra floor space in order to operate effectively and to increase the student training program. At the moment the situation is so urgent that we are about to erect temporary buildings and quonset huts in order to relieve the serious overcrowding. These huts may be acceptable to scientists but in a tropical climate they are bad for delicate instruments.

Another activity in which both our Institute of Marine Science and the International Oceanographic Foundation have been active is in international scientific relations. Since the oceans, their problems and valuable resources are common to all the Americas we are hoping that an international organization of marine scientists in North and South America may be set up. This will not only be of scientific importance but will draw our countries together through these common interests. We have also pioneered in setting up exchange visits between marine scientists of the Nordic countries and our own in order to provide an exchange of ideas that will stimulate our own research as well as promote international good will.

All of these require funds. The International Oceanographic Foundation has been actively engaged in supporting research from private funds, but these sources are insufficient to meet the increased demands of our efforts to modernize oceanography. It is therefore essential that our Government undertake a share of the responsibility.

Specifically we urge that funds for laboratories, apparatus, and research vessels be provided. We also need direct support for the teaching faculty, which is the key to the future production of scientific talent. This is needed above and beyond contract and grant funds which serve specific research ends but neglect the vital function of graduate training.

We believe that the bill now under consideration will remedy the problems outlined above by providing funds for specific purposes and favorable consideration is urged for it, in order to keep the United States a scientific leader among maritime nations. The fact that this bill covers a number of Government departments and agencies is in itself an unusual but highly appropriate approach which we respectfully endorse, because of the concerted effort which it insures.

I am,

Yours sincerely,

F. G. Walton Smith, *Director.*

STATEMENT OF DR. C. P. IDYLL, UNIVERSITY OF MIAMI

Mr. Idyll. Mr. Chairman, I have a prepared statement. With your permission I will not read it. Instead I might comment on and amplify some of the things there.

The Chairman. We will put the statement in the record in full.

Mr. Idyll. Thank you.

(Statement follows:)

Statement by Dr. C. P. Idyll, University of Miami

My name is Clarence P. Idyll. I am chairman of the Department of Marine Sciences of the University of Miami, chairman of the the Division of Fisheries of the Institute of Marine Science (Marine Laboratory) of the University of Miami, and chairman of the Gulf and Caribbean Fisheries Institute. I have the Ph. D. degree from the College of Fisheries of the University of Washington, Seattle, Wash., and B.A. and M.A. degrees in zoology from the University of British Colombia. I have been at the University of Miami for more than 12 years; prior to that time I served on the staff of the International Pacific Salmon Fisheries Commission for 8 years.

In the Department of Marine Sciences at the University of Miami, we are training oceanographers, marine biologists, and fishery biologists at the graduate level, awarding the M.S. and Ph. D. degrees. The training of these students is given by senior members of the research staff of the Institute of Marine Science, whose total number is about 180. The total number of graduate students enrolled in our department now is 53.

This number of students at our institution is too low if we are to supply the Nation's needs. The expansion of research activities in oceanography which many people believe to be essential to the welfare of the United States, and which is envisioned by S. 901, would require a large number of trained scientists in addition to those in the profession at present. The careful study of the status of the science by the Committee on Oceanography recognized that the greatest bottleneck facing the program was the lack of scientists and the slow rate at which students were being trained.

Our institution feels deeply the responsibility for helping to supply this need, and we are striving to produce more marine scientists. Interest in the marine science has risen sharply in the last few years. This is illustrated by the increasing numbers of inquiries from students desiring admission to our graduate program. These have increased about tenfold in the last 9 years.

Numbers of students desiring admission to graduate work in marine sciences, University of Miami

1953	40	1956	136	1959	248
1954	63	1957	126	1960	[1]389
1955	149	1958	148	1961	[2]101

[1] 77 in first 2 months.
[2] In first 2 months.

We cannot take more graduate students than we presently have, although we would like to enroll at least 100, and preferably more. In order to do this and still provide good training, we require the following:

1. Support for faculty.
2. Fellowships for students.
3. Classroom and laboratory space.
4. Equipment and supplies.
5. Ships and ship time.
6. Continued long-term research grants.

It can be argued that these are all the responsibility of the university and that the citizens of the United States should not be expected to pay for professor's salaries, laboratory equipment, and the other items. The recent report of the President's Science Advisory Committee, entitled "Scientific Progress, the Universities and the Federal Government," effectively disposed of this argument. This report is commended to the attention of anyone interested in scientific research and in higher education in the United States.

The report emphasizes throughout the interdependence of research and graduate education:

"It is a fundamental contention of this report that the progress of graduate education and the process of basic research *belong together* at every possible level. We believe that the two kinds of activity reinforce each other in a great variety of ways and that each is weakened when carried on without the other" and "The truth is as simple as it is important: *Whether the quantity and quality of basic research and graduate education in the United States will be adequate or inadequate depends primarily on the Government of the United States. From this responsibility the Federal Government has no escape. Either it will find the policies—and the resources—which permit our universities to flourish and their duties to be adequately discharged—or no one will.*" [Italics theirs.]

The Institute of Marine Science in Miami was well staffed for the previous number of students, but in order to cope with the present and future numbers, support is needed to obtain additional staff and to release more of the time of scientists for this activity. The university, a private institution, cannot, unaided, support the size faculty required for the task we have set ourselves. The university does not expect the Federal Government to carry the full load and will always continue to carry a considerable part of these faculty salaries as well as the other costs, but a material amount of help is essential.

The necessity of more fellowships in more liberal amounts has been stressed on many occasions, but deserves to be repeated. To quote the President's Advisory Committee report again, "Graduate studies leading to the Ph. D. are very expensive, both for the university and for the student, and neither party is adequately supported. * * * Too many students simply cannot find the money for sustained full-time study and drop out, or take part-time jobs that delay their progress and flatten their spirits." The provisions in S. 901 for fellowships are welcomed, and are important parts of the bill.

Physical space to provide classrooms and laboratories is one of the principal bottlenecks facing increased training of graduate students in Miami. Despite an increase from about 12,000 square feet of space in 1955 to a present 35,000 square feet, we simply cannot accommodate more students because there is no place to put desks and chairs.

"Continued long-term research grants" is an item listed under the general problem of training of oceanographers because it is the existence of such grants which supplies one of the ingredients absolutely essential to their training. Marine scientists cannot be taught their profession unless they practice it, and Government contracts are the sole source of this work.

We may now turn our attention to the problem of support of oceanographic research by the Federal Government, apart from the consideration of training students. Some of the most important aspects of the bill under consideration are the provisions for Federal support of research groups outside the Federal Government. In the past this support has been too small and largely of the wrong kind, since it has been year-to-year contracts for the solution of specific problems. To quote again the report of the President's Science Advisory Committee: "* * * in its essence the concept of 'purchase of services,' which is implied in any Government contract, was and is a doubtful one, when applied to basic research * * * the support of university research has been hampered by contract rules which strictly limit the ways in which universities can be compensated for their costs. The whole framework is somewhat arbitrary and unrealistic." The report emphasizes the enormous difficulty faced by supervisors of research programs in recruiting and holding able staffs when research support is on a year-to-year basis. Longer term grants are an absolute necessity if stable and productive programs of research are to be established in the universities.

I would like to comment more specifically on this aspect of the bill as it concerns the support of fisheries research. In the past, Federal support for this aspect of oceanography in agencies outside the Federal Government has been neglected. This is because the responsibility seemed to fall between two schools. It does not appear to be the responsibility of the Navy, whose mission is to operate in the area of physical and chemical studies of the ocean and not on biological or fisheries problems. Fisheries research is not the responsibility of the National Science Foundation either, since this agency was not conceived to operate permanently in any special field. In addition, NSF appears to regard all fisheries research as "applied." Clearly the responsibility for fisheries research seems to fall to the Bureau of Commercial Fisheries.

S. 901 provides for authority and for substantial funds to enable the Bureau of Commercial Fisheries to expand their own research substantially. Our institute in Miami supports this wholeheartedly. In addition, however, we are anxious to see this Bureau given the authority and resources to support long-term basic research in fisheries in institutions outside the Federal Government. They have had means to support some contract work from year to year under the Saltonstall-Kennedy Act, but this has all the defects of the "purchase of services" concept criticized earlier. In addition, the Saltonstall-Kennedy funds can be used either by the Bureau of Commercial Fisheries or to contract with outside agencies. Then the Bureau is faced with the unenviable choice of using the money to increase their own activities (with sufficient good projects to absorb many times the money available) or to support research at other laboratories. The Bureau of the Budget is leaving less and less choice in this by substituting Saltonstall-Kennedy funds for regular appropriations.

I believe the bill (S. 901) should be more specific in authorizing the Bureau of Commercial Fisheries to establish a grants branch comparable to ONR in the Navy and the National Institutes of Health in Health, Education, and Welfare, and in providing funds to implement this.

Section 5 of the bill gives the Bureau of Commercial Fisheries authority and direction to "Make grants * * * for basic and applied research programs * * *," but section 6 does not clearly follow this with authorizations of appropriations, since section 6(f) authorizes funds for studies "of utilization of marine products for human consumption * * * etc." while the funds for "marine population sampling, biological surveys, etc," are given solely to supplement the Bureau of Commercial Fisheries budget, under section 6(d). Furthermore, the money in section 6(f) can, apparently, be used either by the Bureau itself or be used for grants and contracts. This opens the way to the same fatal difficulties faced by the Saltonstall-Kennedy program.

It is suggested that the intent of section 5, that the Bureau of Commercial Fisheries make grants and contracts, be spelled out more clearly in section 6. I suggest that half the sums named in sections 6(d) and 6(f) should be set aside for grants and contracts, the other half to be used by the Bureau to expand its own operation.

The Bureau of Commercial Fisheries would set up an office to handle grants and contracts under this system. They should, I think, also use the system employed by NSF and NIH, sending proposals to a committee (permanent or ad hoc, or a mixture) of qualified scientists outside the Government for evaluation In this way the scientific merits of proposals would be given a harder scrutiny than they would if only Bureau personnel read them.

S. 901, with the changes suggested, has the support of the Institute of Marine Science of the University of Miami, and we urge prompt, favorable action on it by this committee.

Dr. IDYLL. I am Clarence P. Idyll, I have a Ph. D. from the College of Fisheries of the University of Washington. I am chairman of the department of marine sciences at the University of Miami. In this department we give graduate work in oceanography, in fisheries, and in marine biology. We grant the degrees of master of science and doctor of philosophy.

All our courses, with two exceptions, are graduate courses.

I am also chairman of the division of fisheries at the University of Miami, Marine Laboratory. In this capacity I am responsible for the fisheries research.

I would like to say something about the graduate training of oceanographers and fishery biologists. At the present time we have 53 students who are candidates for one of the two degrees: master of science or doctor of philosophy. This is the utmost capacity of our department at the moment.

We cannot take any more students because the training is several years in duration. We are only graduating some 8 to 10 students each year. We feel that this is completely inadequate in terms of the Nation's needs for training people in these fields, and we have the aim of at least doubling the number. In other words, we would like to have in training at any particular time at least a hundred students, and possibly 150, because again the number that you can graduate is about a fifth of the number that you have training.

At the moment we are completely unable to accept more than about 50 students in our graduate work. Our situation is similar to that discussed by Dr. Pritchard in that there simply is not space for desks, and chairs in our halls.

Senator SMATHERS. But you do have a large number who seek to get this training?

Dr. IDYLL. Yes, sir.

Senator SMATHERS. But the physical plant is what limits the number of the students, is that right?

Dr. IDYLL. That is correct, Senator.

I have in my statement here the number of people who have made application to our school for the last several years. Starting in 1953, we had 40 such inquiries, and it increased. There was a slight drop during the depression, and then last year, the last full year of inquiry, we had 389 such inquiries. This year for the first 2 months the curve is still rising.

In other words we have a great many people who inquire. Of course some of them are not qualified and would not be taken even if we had the space. On the other hand, as Dr. Pritchard said, we have a lot of people who apply who are qualified and whom we cannot take.

What we need, and what S. 901 provides, is assistance for our school in training these people. I have a list of six things here which we feel are necessary for the Federal Government to assist us in: we need support for faculty; we need fellowships for students; we need classroom and laboratory space; we need equipment and supplies; we need ships and ship time, and continued long-term—may I emphasize that please—long-term research grants.

The CHAIRMAN. Dr. Idyll, of course the bill doesn't envision going into any specific university and giving them classrooms or faculty members as such.

Dr. IDYLL. No, sir.

The CHAIRMAN. But indirectly, because this is a need for the Nation as a whole——

Dr. IDYLL. Yes, sir; I realize that.

The CHAIRMAN. There would be assigned naturally to such schools as the University of Miami, which are in this field, a research grant which would in turn provide these things to do the job.

Dr. IDYLL. Yes, sir. And like Dr. Pritchard, I have taken the liberty of telling you our situation, recognizing it as typical of many other schools.

The CHAIRMAN. The graduate of the oceanography school, the marine scientists coming out of your school, he isn't going to be doing work when he gets out just for the State of Florida?

Dr. IDYLL. Certainly not.

The CHAIRMAN. He will be in a national field, no matter what he does.

Dr. IDYLL. That is correct.

We feel the responsibility for training many more oceanographers because as Dr. Pritchard mentioned, the list is only six or eight such schools, so obviously we have responsibility to the rest of the Nation. And of course our students will not stay in Florida in all cases, although obviously some will.

The CHAIRMAN. Some of them might, but the work they do will redound to the whole national effort.

Dr. IDYLL. We have had statements made that the Federal Government does not have responsibilities to support faculty salaries and some of these other things that I have mentioned. It was very interesting and useful to us to have the statement of the President's Science Advisory Committee come out, because many of the things said in there, and said very forcefully, are things that we have said for years. And it makes a great deal more impact of course to come from such a committee as this.

I have taken the liberty of quoting certain pages from this report in my statement. If I may, I would like to read one of these.

The CHAIRMAN. Yes.

Dr. IDYLL. It is a fundamental contention of this report—and that is the President's Science Advisory Committee——

Senator SMATHERS. Which President is that?

Dr. IDYLL. Mr. Eisenhower, sir:

> It is a fundamental contention of this report that the progress of graduate education and the process of basic research belong together at every possible level. We believe that the two kinds of activity reinforce each other in a great variety of ways and that each is weakened when carried on without the other."

Another quotation from the report:

> The truth is as simple as it is important: Whether the quantity and quality of basic research and graduate education in the United States will be adequate or inadequate depends primarily on the Government of the United States. From this responsibility the Federal Government has no escape. Either it will find the policies and the resources which permit our universities to flourish and their duties to be adequately discharged or no one will.

So it seems to us, then, that this effectively disposes of the argument that the Federal Government has no business supporting the faculty salaries and these other things that I have mentioned that we require in order to expand the training facilities for oceanographers at the University of Miami.

The CHAIRMAN. That is only if the Federal Goverment in the first instance decides that we need more work done in the field of oceanography for the national interest.

Dr. IDYLL. Yes, sir.

The CHAIRMAN. Which I think, basically, has been pretty well decided from the White House on down through Congress.

Dr. IDYLL. Yes, sir; that is my impression.

The CHAIRMAN. There are some exceptions.

Senator SMATHERS. I have heard a little of those exceptions recently in the paper, too. There was the question of the Federal aid to education, which is a little bit involved. But I am on this side, the side of the doctor.

Dr. IDYLL. Like the Johns Hopkins University, the University of Miami is a private institution; and therefore private funds are used to support it. We are completely unable to support the size of organization which we feel necessary to do the job that we have set ourselves.

In other words, we have a staff of some 185 trained scientists, and no university, I believe, public or private, is capable of giving this sort of support unaided.

The training that we give our graduate students is from the senior faculty, senior research people of this institution, so that the training is, we believe, highly valuable to the students in coming from people who are actually engaged in research, and this again is something that this report brings out.

The CHAIRMAN. Let me ask you this question:

If something should happen in this field in the nature of defense, the Defense Department—because this is becoming more important to them as we go under water—would be calling upon you for certain things, would it not?

Dr. IDYLL. Yes, sir.

The CHAIRMAN. You are not prepared to do the things they want to do right now, are you?

Dr. IDYLL. No, sir; this is correct.

The CHAIRMAN. And it would take some time to get prepared, first in the field of qualified people, whom you don't get overnight, and second, in the matter of equipment, which you just don't build overnight.

Dr. IDYLL. Yes, sir, that is correct. And in particular you can usually build a machine fairly expeditiously, but you cannot train scientists——

The CHAIRMAN. In your specific approach, I think probably your enthusiasm for this stems from, if anything, the importance of getting some trained people in this field.

Dr. IDYLL. Yes, sir, and this is the thing I hope to emphasize in this testimony.

Senator SMATHERS. May I ask a question there, Mr. Chairman, more of you than the witness.

Does the Defense Department give any recognition to the importance of this area in its efforts?

The CHAIRMAN. Oh, yes. There are some No. 1 priorities down there in the field of marine science; big priorities. Particularly in view of the fact that a part of the emphasis is on underwater defense, and particularly in view of the fact that the Soviet bloc is proceeding with great rapidity in this field.

I will say to the Senator from Florida, I am on the Space Committee, too, and handle their appropriation. We argue about whether there are lags there, and that is subject to political argument. But no one has ever said that there is not a lag in the oceanographic field. The University of Miami, as one prime example, is trying to do something about it.

Senator SMATHERS. Your contention is that it is just as important to explore the cellar as the attic.

The CHAIRMAN. Yes.

Dr. IDYLL. If I may briefly mention something about each of the six points I brought up, and I promise to be brief.

We require assistance for our faculty in order to train the people that we have, because at the present time these people borrow time from their research jobs to teach. I don't mean by this that they are improperly borrowing this. But what I mean is that the amount of time that the university is able to pay for the instruction is inadequate. This is one of the reasons that we cannot train more than 50 instead of the 150 students that we would like to have.

Secondly, the need for fellowships has been talked of so often that it hardly needs to be emphasized. Yet let me say that it does require emphasis.

You buy graduate students the same as you buy any other commodity. Unless you have a high price tag on these people, you are not going to get them.

Dr. Pritchard, if I may repeat what he said again, mentioned people who started out in oceanography but were forced to go somewhere else for lack of support. This is most important, and I am delighted to see that S. 901 provides for this. It is a most important part of the bill.

We need space. The space at the Marine Laboratory has increased from some 12,000 square feet in 1955 to the present 35,000 square feet. Despite this rapid increase we find ourselves hanging from the rafters. We need immediately 10,000 more square feet just to train the people that we have now.

I mentioned in terms of training students the necessity for long-term grants. The committee may wonder why we talk about research in connection with training of students. I think anyone in the profession knows that you must have research going on in order to train students because you can't train a person to dance without having them practice dancing; you can't have them learn how to do research without practicing research. And this is where the research grants come in.

In my capacity as head of the fisheries division at the University of Miami I spend far too much of my time attempting to renew short-term research grants. It is a very great necessity, if oceanography is to advance at the rate that we believe it should, that we have long-term grants and not year-to-year grants. The trend is this way, and the trend must continue if we are to do what we aim here to do, what the committee is attempting to do, what the bill is attempting to do, and what most oceanographers attempted to do.

If I can pursue this, if I may leave the training of students for a moment and talk about research grants and talk now in my capacity as head of the research division.

The great problem in fisheries research, I was trained in your State, sir, in the University of Washington; I am now in another State.

The CHAIRMAN. We are sorry to lose you to Florida.

Senator SMATHERS. Every man is entitled to go up in life. [Laughter.]

Dr. IDYLL. New work in other States——

The CHAIRMAN. Let me interrupt there, not being facetious about it. This is an example of what we mean, when you are training people down there, we have to use them all over.

Dr. IDYLL. Oh, yes.

The CHAIRMAN. This field is very limited now.

Dr. IDYLL. We have our graduates in many parts of the country now and we don't aim to keep the boys that we put out, or the girls.

In the matter of research grants, we have had some trouble in fisheries research because the responsibility for fisheries research does not belong in anything but apparently the Bureau of Commercial Fisheries, because a specific small part of oceanographic research is not the responsibility of the National Science Foundation, I believe. Special parts of the research have never been their responsibility, and we have found it very difficult to get support for fisheries research because the State of Florida has a certain limited capacity to support this research. The National Science Foundation considers it outside their scope, and I think properly so. It certainly doesn't belong in the Navy. It belongs in the Bureau of Commercial Fisheries.

The Bureau of Commercial Fisheries does not have the resources, and I am not certain whether it has the power, to give long-term grants as opposed to contracts. We feel that your bill provides for this, but we would like to see a somewhat stronger statement in this connection in the fact that more specifically the Bureau of Commercial Fisheries is given the power and authority to set up a granting branch. We would like to suggest, sir, that the only part of the bill that seems to us to require modification is this: that the Bureau of Commercial Fisheries be authorized to set up a granting agency to give long-term grants as opposed to contracts so that organizations like ours will have long-term grants where we can apply ourselves to problems that need solution in the fisheries, and at the same time train graduate students because we believe that these are absolutely inextricably combined.

It seems to us that section 6 of the bill does not spell this out in as specific terms as we would like.

The CHAIRMAN. I think that we are going to have to make some modifications in the bill. The real problem is—and no one knows it better than my friend Dr. Chapman, sitting here—that when these agencies, such as the Bureau of Commercial Fisheries, believe they should be doing something through you, they have to go through all the housekeeping of their respective departments and the department budget. That is pretty much a year-to-year operation. We are hopeful that this will have the effect of not taking away from any department what is being done there or what they need to do, but as a matter of fact beef up their programs, do more in all these fields, whether it be the Navy or the Bureau of Commercial Fisheries. The purpose is to have some kind of an overall plan on long-range research in which the right hand knows what the left hand is doing, so that when the Bureau of Commercial Fisheries goes to the Secretary of the Interior and suggests funds to do a particular job it thinks should be done, say, in your shop, they would be backed up by the overall plan rather than just making their effort all alone.

This is some job when you get to departmental budgets. Scientific research has been the sort of thing which has been an orphan. It comes last. Other things have the priorities.

I think that if there is any misconception that any kind of an overall plan would take away from the departments what they should do, it is a wholly mistaken interpretation because we want them to do more.

Dr. IDYLL. That is right. I think my written statement makes it perfectly clear that we are not suggesting that the Bureau of Commercial Fisheries be given less power or less money.

The CHAIRMAN. They should be doing more.

Dr. IDYLL. Far more.

The CHAIRMAN. And we want them to do more.

But it is a budget problem, a money problem, and they are limited in what they can do because they have to do it in an isolated way.

Dr. IDYLL. We are hopeful, Senator, that the Bureau of Commercial Fisheries will have some sort of branch equivalent to the old ONR, perhaps, where it is the stated policy of the organization to make long-term grants as opposed to short-term contracts, and that this not be so arranged that it results in less work being done by the Bureau of Commercial Fisheries, but on the contrary that it supplement their work.

In conclusion, sir, we are very pleased indeed with the genuine intent of the bill, and it has the support of our institution, and we wish it every success.

The CHAIRMAN. Thank you very much.

Are there any further questions?

Senator SMATHERS. No, thank you.

The CHAIRMAN. Dr. Chapman?

We will hear from Dr. Chapman, and then, if it is agreeable, and doesn't inconvenience the witnesses too much, we will meet at 9:30 tomorrow morning, and we can probably hear other witnesses. This is unavoidable.

STATEMENT OF DR. W. M. CHAPMAN, DIRECTOR, THE RESOURCES COMMITTEE, SAN DIEGO, CALIF.

Dr. CHAPMAN. Mr. Chairman, in the interests of saving your time I will read some parts of the statement, skip over others, talk on some parts, and ask for the statement, with the four appendixes, to be put in the record if that is permissible.

The CHAIRMAN. I want to say that the chairman is quite familiar with your ideas on this subject. You can direct your statements to the Senator from Florida, and I will corroborate them.

Dr. CHAPMAN. My name is W. M. Chapman. I am director of the Resources Committee, 1 Tuna Lane, San Diego, Calif. I am here representing views from the southern California fishing and fish-processing industry with respect to the Marine Sciences and Research Act of 1961, S. 901.

Although our industry is situated and headquartered in southern California, units of it operate over a considerable section of the world oceans and are situated in several countries located on four continents and in Oceania.

Tuna fishing vessels from southern California operate regularly in the eastern Pacific, in season, from the State of Oregon on the north to northern Chile on the south, around the offshore islands in this area—Revillagigedos, Clipperton, Cocos, and Galapagos—and to distances 500 miles or more off the coast. We have several vessels presently working with the Russians off the west coast of Africa, trying to make a go of things.

The CHAIRMAN. What are the Russians doing in west Africa?

Dr. CHAPMAN. We are catching tuna and trying to make a living. The Russians are catching sardines, and what else we don't know. They have a good deal of electronic equipment aboard their boats, much more than we have, and we haven't seen it all.

We are in the process of expansion. As the Senator will remember, for years we went downhill sharply. We have vessels now being prepared to enter the fleet with as much as a thousand tons' carrying capacity. I might say that these are vessels out of the mothball fleet that are being brought out and refitted as fishing vessels, and I think that they will be considerably the largest and longest lived fishing vessels that the United States has had since the whaling days.

Our companies operate in a large number of countries around the world. They accept fish from vessels of many countries. I mentioned the details of our operation to indicate why our views respecting ocean research are so wide. We are not just interested in the coast of California, but we are worldwide in our interest, and almost as catholic in our views as you are, sir. I want to treat briefly these interests in three segments.

The CHAIRMAN. Doctor, you have a good statement here. This is something that we Senators can use. You say, "We believe the Nation's interest is as boundless as the sea itself."

Dr. CHAPMAN. That is our belief. We have every reason to think that that is true.

We favor strongly the adoption of the bill exactly as it stands. We would also favor the adoption of the bill if its details were considerably amended so long as those amendments do not limit the breadth of the U.S. Government's ability and authority to inquire into the physical, chemical, and biological processes of the high seas of the world, the bottom below it and the air above, and so long as those amendments do not dilute the objectives of the bill by spreading them over inquiries concerning the inland and strictly coastal waters of the Nation.

With respect to the former, I will repeat what you said, that we believe that the Nation's interest is as boundless as the sea itself; with respect to the latter, we believe other bills and other means are adequate to properly cover the Nation's interest in the inland and coastal waters, that the sector of the Nation's ignorance upon which S. 901 is properly concentrated is that of the ocean out of sight of land, and that dilution of the bill to accommodate inland and coastal objectives will defeat its purpose by spreading the rather skimpy funds—and I would like to say that these are rather skimpy funds which are envisioned in the bill—it authorizes over so much scientific inquiry that the Nation would remain, after its passage, about as ignorant concerning the high seas as it is now.

In our view, this bill is primarily concerned with getting funds allocated to ocean research adequate to learn what the Nation needs to know about the ocean. Heretofore and presently most of the Nation' s ocean research facilities and agencies have been scattered through the structure of the executive branch in such a fashion that most parts of them are small units in large agencies. Each of them gets starved by having larger entities in the agencies get all of or most increases in appropriations. In consequence of this, the whole ocean research establishment of the Nation is undernourished and incompetent for its great tasks.

The result of these processes is that although the United States, as the paramount leader of a confederation of nations held together by the sea, absolutely requires to have (with its confederates) command of the sea and knowledge about how it works, it is being outdistanced in the rate of acquiring knowledge about the sea, and the use of the sea's resources, by its chief competitor, Russia and its allies. Indeed, within the confederation of the free world, smaller nations such as Japan, England, Denmark, Norway, Germany, and France—not the United States—have been noted heretofore for their ocean researches and have built the history of ocean research to which we have lately come.

We view the primary purpose of this bill to be the drawing together into one skein of all these threads of ocean vessels in the executive establishment so that that skein as a unit will bulk large enough to require budget officers to allow sufficient moneys to be allocated to the whole of the ocean research establishment in the Nation so that it can accomplish its appointed tasks and responsibilities.

The Bureau of the Budget and the departmental budget officers did not want this legislation passed by the last Congress and I predict that they will cause it to be opposed, or amended into innocuousness, or damned with faint praise in this Congress. The reason for this essentially is that these officers do not wish to have the Congress limit their control over the allocation of funds in the Federal budget nor to call attention to the inadequacy with which they have furnished funds to this critical area of scientific inquiry in the past.

There has been so much talk about oceanography since the N.A.S.-N.R.C.'s Committee on Oceanography began its work, since the Congress began its consideration of the subject, and especially since an ocean-oriented President has been elected, that the casual observer of the national scene must believe that the Nation's ocean research is in a flourishing state. Nothing could be further from the case. The ocean research establishment of the Nation is very little better off for funding than it was 3 years ago when you began your work, and in certain important respects it is worse off.

As one example of the latter, one may point out that the Bureau of Commercial Fisheries of the Department of the Interior has less ocean research ships at sea now than it had 5 years ago and that it has actually been laying up ocean research ships for lack of funds with which to operate them and keep them at sea.

The Nation's ocean research has been further hampered because of a lack of higher, so-called supergrade positions. These just don't seem to be available for our oceanographers. As a consequence, the Government cannot bid for and obtain the services of top ocean scientists to plan and lead its ocean research work.

I might say in connection with what Dr. Idyll and Dr. Pritchard said, if you get funds to support graduate students—and I have been in that business myself, you will remember—and if you get research money to keep them alive while they are going through college, you still aren't going to get the best men because so long as your salary range in the top jobs in oceanography in the country is low, the smart boys are going to drain off into space work, into atomic fission, into medical work, or wherever there is a better field for their talents, and you won't get the best people so long as you keep the salary scale low. This is pretty nearly all governmental work, and the Government rates set the pace. Until you get some of these special positions into the oceanography area, you are just not going to have the development of the staff that you need in the country.

No one in the country is better acquainted with the intransigence of the Bureau of the Budget and departmental budget officers in providing funds for ocean research than the chairman of this committee. It was you who took the lead in seeking the passage of the Saltonstall-Kennedy Act, for example. The principal purpose of that act was to bypass the budget officers and pump new funds into fisheries research. They didn't like it. It was you who took the lead in reorganizing the Department of the Interior's handling of fishery affairs which resulted in the Fish and Wildlife Act of 1956. A principal purpose of that act was to raise the status of fishery work in Interior to where it would have a budget of its own to defend by giving it the status of a Federal bureau, and to increase and make permanent the funds provided by the Saltonstall-Kennedy Act. It is you who has taken the lead in implementing the NASCO report through an omnibus Ocean Research Act, which we all favor so strongly. The prime purpose of this bill is to pump funds into ocean research.

We have followed with praise and support each of Senator Magnuson's efforts over this long period of years as we do now. We have to report that you have not done very well, and neither have we in helping. We spent a lot of time trying to blast or wheedle funds for ocean research from the land-oriented officials of the Bureau of the Budget and the Departments of the Interior and Commerce have had very modest success to date.

I should like to point out, for example, that the Bureau of Commercial Fisheries is by no means in the status of a Federal bureau as provided by law. They do not have a separate budget of their own to defend. They are in the Bureau of the Fish and Wildlife and in the status actually of a division, and both their budgets meld together before they run into the Bureau of Indian Affairs, for instance.

I will also predict that once again the Bureau of the Budget will force the departmental witnesses on S. 901 to testify that the bill is not necessary and that Senators and Congressmen will take great delight in crucifying each of these witnesses when both they and the witnesses know that the opposition stems not from the witnesses, who want the bill passed, but from the budget officers who do not.

I don't want to comment on the details of the bill, Senator. We favor it. Details have been worked out with great care by yourself and your staff. It is an excellent bill. I only want to highlight what the two previous witnesses said on this matter of training oceanographers which is now provided for adequately in the bill, which is one of critical importance. You can't get the work done without the trained scientists.

We are interested primarily in three areas of the ocean. It will be my purpose below to treat briefly of those interests in three segments of the world ocean by way of example. These are: (1) The eastern Pacific between 30° north latitude, 20° south latitude, 140° west longitude and the western coasts of the Americas; (2) the California Current area off the west coast of the continental United States to a distance of about 1,000 miles from shore; and (3) the eastern Atlantic from 20° north latitude to 10° south latitude and to a distance of about 1,000 miles from the African coast. Before doing so I wish to make some general comments on the bill.

The reason we are interested in that is that we know there are enormous quantities of skipjack in the area. It is as big as the map of the United States. We know there are a lot of skipjack there. We don't know how to get them economically enough at present prices to make a living at it. At the same time our expanding fisheries are bringing pressure on the yellow fin, and we know we have regulations coming in a little while. So the sensible thing to do is divert our fishing effort over from the yellow fin stock over to the skipjack stock in the area and increase the harvest from sea. We can't do it without further oceanographic information so that the fishermen will have knowledge of within 100 or 200 miles of where to go to look for the fish.

We have been 7 years trying to get that program started because we knew what the necessities were going to be 7 years hence. We are now coming to the point where we need the information and the work has not been any more than briefly started. Every time that we have tried to get money—and I may remark that you have helped us on every occasion—somehow or other the money disappears before it is appropriated.

It is hard to get the modest appropriations we require. We are after only $300,000 in that area, and that is a small amount of money as people can't seem to realize.

What we are now undertaking to do is to join with the naval laboratories, the scientific institutions, the Weather Bureau, the Atomic Energy Commission, and other entities interested in the same piece of ocean to draw up a program, a comprehensive program of research for this largely unknown section of ocean which is so important now to the Nation's defense as well as our little piddling skipjack production. We have as much shipping go through that area ourselves as anybody else, and we are hardly set up to gather the information that the Navy wants. The Navy will fix us up with instrumentation and a little assistance on how to run it. We have boat time in there. That is expensive.

With the cooperation of the Navy, which we are going to begin to get, I think we can help the Navy materially in the area.

I will mention the second field of our interest, if I can skip away and drop that, here on the coast of California itself, and the coast of Oregon and Washington. Mr. Reid will tell you more about that.

I may say that the State of California in this little bit of ocean covered by my fingers spends in the neighborhood of $2 million a year in ocean research. I remember the State committee that helped in this respect. We have been doing that for the last 10 years, and we believe that the waters within 500 miles of the State of California are better known and understood than any section of the ocean in the world, with the possible exception of the Northeast where they have been in about three times as long as we have.

While we feel that that is the case, we are very dissatisfied with the state of our situation out there. Many new demands for this informaton are coming upon us from the Atomic Energy Commission, from the State pollution board, from the State small harbors commission, from the State beach erosion board, and sports fishermen, and every other Tom, Dick, and Harry who learns that he can use the ocean. We are not set up to adequately provide the information that these people want, in spite of our large program. Therefore, the committee at its last meeting in San Francisco, in early March, did two things: It asked the Governor to cause to be convened a committee of the nature of NASCO—the National Academy of Science on Oceanography—to look over our whole ocean research program in the State of California, how it is integrated to the needs of the State of California, and also of the Nation, and how it is integrated with the research program envisioned in this bill and in the NASCO reports.

We are in hope that the Governor will ask the National Academy of Science for use of a panel thereof to aid us in that, so that our program which eventuates will be as well done as that one was, and also we will integrate into the Nation's overall ocean program.

The second thing we have done—and you will be surprised how hard this has come—we asked our collaborating scientists to forget about budgets for the time, to forget about budgetary controls, and draw us up a program of what ought to be done out there. The first time they did this, the first round at this, it was rather surprising that they couldn't do this. They had been working under strong budgetary controls for so long, with skimpy funds, that they found it difficult to think in the broad way that the committee wanted them to do.

We sent their report back to them and asked them to do it over again. They did come up at our March meeting with what we felt to be a much more comprehensive and adequate program of research. We adopted tentatively the first three sections of it and told them that we are going to start rustling up some money for them in whatever way we could to put this afoot. But we still were not very satisfied with the comprehensiveness of their program. We wanted them to go back and study it again and bring us a real good program that we could put afoot in the ocean off the State of California.

I think in some ways what the States have been doing has been left out of the NASCO report. They have concentrated on the Federal programs, which they are properly set up to do. I merely want to point out as an example that our State—and Senator Smather's State also—is doing a very considerable amount of research, and so is your State, Senator. These programs are required to be integrated into the program, the national program. Furthermore, there is no reason why money can't be raised from State treasuries to help out in the program. We have done pretty well in the State of California, and also in the State of Florida. We have been pretty slow in the State of Washington to put out money in this way.

I will leave that and skip over lightly to west Africa a new area of interest to us in just the last few years. In fact, our actual fishing operation has been underway there for less than 18 months. We have one company presently with two purse seiners operating out of the base at Sierra Leone and another company operating out of a base in Ghana with presently three vessels. There are other vessels on the way. I suspect that before the year is out we will have another half dozen and maybe as many as a dozen vessels over there.

The tuna production in the eastern Atlantic, latitude for latitude, is very similar to that in the eastern Pacific. We know this area so well over here now that we can almost predict what it will be over there, and go over there with the boats and catch them. It is not quite that simple because we have not finished the exploratory phases of the operation yet.

I may notice that you called our attention to the fact that the Russians are there, the Poles, the Germans, and also the Norwegians, Portuguese, Italians, the French, and the Japanese in a large way, and, rather interesting to me, three vessels from Nationalist China. All of these nations are fishing here and building big fisheries rapidly. Right along in this band [indicating on map], along the top of the Gulf of Guinea, from Ghana over to the Congo. The jungle is where a large number of humans live. There are about 50 or 60 million people who live in the shadow of my hand here, in the jungle. The tsetse fly also lives there and kills off most of the livestock so we have no beef; we have no edible animal protein there to amount to anything at all. The game is similarly scarce, both because of the tsetse fly and also from the humans killing it off over the years.

So you have a great big bunch of people here who are real hungry for protein, and who need it badly. Nigeria, for instance, imports about $25 million worth of dried stock fish from Iceland and Norway. They can't afford it, they can't afford the foreign exchange but they have to have the protein food in their diet. Despite this, they are very short of protein food.

This whole bunch of people, protein deficiency is a normal factor of live for their whole life. A very large cause of the high infant mortality rate down there, with the children from 3 or 4 up to 6 or 7 years of age, the major cause of infant mortality is the deficiency disease called kwashiorkor.

The ridiculous part is that right off shore is a big, heavy fish-producing area of the world. A very productive area. They have the equatorial counter current coming in here, producing a short upwelling along the coast and, as you know, where you have a lot of upwelling, you have fish, a very productive area. We know this from our own operations and also the Russian operations.

So you have a bunch of hungry people and the food that they want within 150 miles of each other, and they can't get together because these people on shore have only dugout canoes and you can't produce much food from the ocean with a dugout canoe, even if you are a good paddler. These people are getting acquainted with this because of our operations and the Russian operations there. The Russians are moving in to take advantage of this as they always do for political purposes. The Poles recently guaranteed Guinea, for example, the construction of a full-fledged fishing industry down there: boats, processing plant, training of the people, just giving it to them. Russia is doing the same thing with Ghana.

You know from your source of information that Guinea is on the other side of the fence already, and Ghana is kind of on edge. It seems to us, running through this area with our commercial intelligence and so forth, that the smart thing to do is for the United States to start putting a little money in there for research, and a little help to help these folks to get the fish out of the ocean and into their bellies. We have proposed some ways by which this could be done. I have, for the record, letters that we have written to Mr. Henry Labouisse, the head of the International Cooperation Administration, also to Governor Williams, both of whom we have talked to on this subject. We will be glad to help in any way that we can.

We want to point out to the United States that here is a real good place to use fisheries and ocean research to provide diplomatic benefits. The countries there we want to be for the United States and to do other things to help us. They want very badly, for instance, an oceanographic fisheries survey in this area. I sat through meetings in Dakar in the month of December where this was brought out. The delegates there from about 14 African nations want this survey quickly, and they said in a friendly way that they didn't care who did it, East or West, they just want it done.

It is fairly important that the U.S. Navy get the oceanographic information here, and not the Russians, maybe. I don't know about that. But it seems to me that here is another aspect of your bill which perhaps wasn't envisioned, the worldwide implications of this bill, not only on the economics of the world but also to a high degree on diplomacy.

I think, sir, that that is all that I have to say on the subject.

The CHAIRMAN. Dr. Chapman, I want to thank you. Of course, I am very familiar with your lifetime activity in this field, and during the war in the Pacific. It seems to me that we could do a great deal for very little money to show these people how to get protein foods as we tried to do in the Pacific area, and to create more good will and create a lot of confidence. It does have that aspect.

Also, I thoroughly agree with what you have to say about the budget situation.

Dr. CHAPMAN. If there is anything that I have said that is offensive to the budget officers, it is because I meant it. This is the hardest row we have to hoe. Budget officers don't mind spending words; they don't like to spend money. They talk and talk oceanography but when it comes down to the hard bone of it, you are laying up research ships instead of putting them to sea. I can give you a half dozen examples on the Pacific coast where it has been done in the last 5 years.

The CHAIRMAN. Let me ask you one thing: You are familiar with our research fleet——

Dr. CHAPMAN. Yes, sir.

The CHAIRMAN. In fisheries and in oceanography. Would it be a fair statement to say that it is in about the worst condition of any nation engaged in this field?

Dr. CHAPMAN. It is in worse condition than it was 5 years ago.

The CHAIRMAN. And in worse condition than it was 5 years ago?

Dr. CHAPMAN. Yes, sir. Let me give you an example. We stole a boat off Senator Smathers. We had two research vessels working in the Gulf of Mexico. We have one working in the State of California. The reason for this is that the bottom fell out of our research ship. We just couldn't fix it up in the State of California. So the Bureau of Commercial Fisheries didn't have the money to operate two vessels in your area, Senator Smathers, and were kind enough to loan one of those vessels to the State of California. We fixed it up and are using it in the State of California. That leaves you one short.

In the State of Hawaii they had three vessels working out there. One of them they put out of commission entirely, the *Manning*. The second one they didn't have money to operate it, the *Smith*. She has been donated for the time being to the Scripps Institution of Oceanography because the Bureau of Commercial Fisheries didn't have the money to operate it.

We have the *Black Douglas*, an old beatup yacht from prewar days, made over, and she is being used about two-thirds of the time now because there isn't money for it. You talk about the scarcity of oceanographers. The oceanographers have to act as crew because they haven't money to hire crews. They operate on such a basis. It is a shameful situation.

The CHAIRMAN. Do you have any further questions?

Senator SMATHERS. No. You have made a very good witness.

The CHAIRMAN. Thank you, Dr. Chapman.

(Dr. Chapman's statement follows:)

STATEMENT OF W. M. CHAPMAN, DIRECTOR, THE RESOURCES COMMITTEE, SAN DIEGO, CALIF.

My name is W. M. Chapman. I am director of the resources committee, 1 Tuna Lane, San Diego, Calif. I am here representing views from the southern California fishing and fish processing industry with respect to the Marine Sciences and Research Act of 1961, S. 901.

Although our industry is situated and headquartered in southern California, units of it operate over a considerable section of the world oceans and are situated in several countries located on four continents and in Oceania.

Tuna fishing vessels from southern California operate regularly in the eastern Pacific, in season, from the State of Oregon on the north to northern Chile on the south, around the offshore islands in this area (Revillagigedos, Clipperton, Cocos, and Galapagos), and to distances 500 miles or more off the coast. Several vessels (presently five but probably more soon) operate off west Africa out of ports in Sierra Leone and Ghana and regularly navigate through the Caribbean and tropical Atlantic. Our vessels in recent years have conducted exploratory fishing trips in the Marquesas, Tuomota, Line and Phoenix Islands of eastern Oceania, and as far south as Juan Fernanez Island off Chile.

Vessels are presently being prepared for commission in the fleet whose size (up to 1,000 carrying tons) and range is deliberately designed to permit customary fishing operations in the eastern Pacific, eastern Atlantic, or central Pacific, whichever seems best at any particular season from the standpoint of fish availability and market conditions.

Our fish processing firms are all headquartered in southern California but among them are also operated canneries, refrigeration, or other fish processing facilities (either by themselves or by means of firms owned jointly with other entities) in American Samoa, New Hebrides Islands, Peru, Ecuador, Colombia, Mexico, Puerto Rico, Sierra Leone, and Ghana. Other plants are being planned for installation elsewhere in west Africa, western Europe, and the Caribbean area.

These companies operate refrigerated transport vessels, either owned or chartered by them, to transport raw material and supplies between those points. To these plants are delivered catches not only of American-flag vessels and vessels of the countries in which they are situated, but also of Japanese, Spanish, French, Norwegian, Nationalist China, Korean, and Portuguese vessels which make their catches in the tropical, subtropical, and temperate Pacific, Atlantic, and Indian Oceans.

I have mentioned these details of our operations to illustrate why our views respecting ocean research are not parochially limited to the sea off California but are indeed worldwide in scope and almost as catholic as those of Senator Magnuson, as expressed in S. 901, and of the national interest as expressed in the reports of the National Academy of Science—National Research Council's Committee on Oceanography.

It will be my purpose below to treat briefly of those interests in three segments of the world ocean by way of example. These are: (1) The eastern Pacific between 30° north latitude, 20° south latitude, 140° west longitude and the western coasts of the Americas; (2) the California Current area off the west coast of the continental United States to a distance of about 1,000 miles from shore; and (3) the eastern Atlantic from 20° north latitude to 10° south latitude and to a distance of about 1,000 miles from the African coast. Before doing so, I wish to make some general comments on the bill.

We favor strongly the adoption of the bill exactly as it stands. We would also favor the adoption of the bill if its details were considerably amended so long as those amendments do not limit the breadth of the U.S. Government's ability and authority to inquire into the physical, chemical, and biological processes of the high seas of the world, the bottom below it and the air above and so long as those amendments do not dilute the objectives of the bill by spreading them over inquiries concerning the inland and strictly costal waters of the Nation.

With respect to the former, we believe that the Nation's interest is as boundless as the sea itself; with respect to the latter, we believe other bills and other means are adequate to properly cover the Nation's interest in the inland and coastal waters, that the sector of the Nation's ignorance upon which S. 901 is properly concentrated is that of the ocean out of sight of land, and that dilution of the bill to accommodate inland and coastal objectives will defeat its purpose by spreading the rather skimpy funds it authorizes over so much scientific inquiry that the Nation would remain, after its passage, about as ignorant concerning the high seas as it is now.

In our view, this bill is primarily concerned with getting funds allocated to ocean research adequate to learn what the Nation needs to know about the ocean. Heretofore and presently most of the Nation's ocean research facilities and agencies have been scattered through the structure of the executive branch in such a fashion that most parts of them are small units in large agencies. Each of them gets starved by having larger entities in the agencies get all of or most increases in appropriations. In consequence of this, the whole ocean research establishment of the Nation is undernourished and incompetent for its great tasks.

The result of these processes is that although United States, as the paramount leader of a confederation of nations held together by the sea, absolutely requires to have (with its confederates) command of the sea and knowledge about how it works, it is being outdistanced in the rate of acquiring knowledge about the sea, and the use of the sea's resources, by its chief competitor, Russia and its allies. Indeed, within the confederation of the free world smaller nations such as Japan, England, Denmark, Norway, Germany and France—not the United States—have been noted heretofore for their ocean researches and have built the history of ocean research to which we have lately come.

We view the primary purpose of this bill to be the drawing together into one skein of all these threads of ocean research in the executive establishment so that that skein as a unit will bulk large enough to require budget officers to allow sufficient moneys to be allocated to the whole of the ocean research establishment in the Nation so that it can accomplish its appointed tasks and responsibilities.

The Bureau of the Budget and the departmental budget officers did not want this legislation passed by the last Congress and I predict that they will cause it to be opposed, or amended into innocuousness, or damned with faint praise in this Congress. The reason for this essentially is that these officers do not wish to have the Congress limit their control over the allocation of funds in the Federal budget nor to call attention to the inadequacy with which they have furnished funds to this critical area of scientific inquiry in the past.

There has been so much talk about oceanography since the NAS-NRC's Committee on Oceanography began its work, since the Congress began its consideration of the subject, and especially since an ocean-oriented President has been elected, that the casual observer of the national scene must believe that the Nation's ocean research is in a flourishing state. Nothing could be further from the case. The ocean research establishment of the Nation is very little better off for funding than it was 3 years ago and in certain important respects it is worse off.

As one example of the latter, one may point out that the Bureau of Commercial Fisheries of the Department of the Interior has less ocean research ships at sea now than it had 5 years ago and that it has actually been laying up ocean research ships for lack of funds with which to keep them at sea.

The Nation's ocean research has been further hampered because of a lack of higher, so-called supergrade positions. These just don't seem to be available for our oceanographers. As a consequence, the Government cannot bid for and obtain the services of top ocean scientists to plan and lead its ocean research work.

No one in the country is better acquainted with the intransigence of the Bureau of the Budget and departmental budget officers in providing funds for ocean research than the chairman of this committee. It was he who took the lead in seeking the passage of the Saltonstall-Kennedy Act, for example. The principal purpose of that act was to bypass the budget officers and pump new funds into fisheries research. It was he who took the lead in reorganizing the Department of the Interior's handling of fishery affairs which resulted in the Fish and Wildlife Act of 1956. A principal purpose of that act was to raise the status of fishery work in Interior to where it would have a budget of its own to defend by giving it the status of a Federal bureau, and to increase and make permanent the funds provided by the Saltonstall-Kennedy Act. It is he who has taken the lead in implementing the NASCO report through an omnibus ocean research act. The prime purpose of this bill is to pump funds into ocean research.

We have followed with praise and support each of Senator Magnuson's efforts over this long period of years as we do now. We must report, however, that all of these efforts of the Congress, and we who live by the ocean, to blast or wheedle funds for ocean research from the land-oriented officials of the Bureau of the Budget and the Departments of the Interior and Commerce have had very modest success to date.

I should like to point out, for example, that despite the great fanfare of publicity about the Department of the Interior's expanded research program, the net increase of operational funds for ocean research in the Department's regular budget now before the Congress is precisely zero. With the great enthusiasm for ocean research which President Kennedy has carried from his Senate and Boston knowledge of these problems, it would look as if this deep-seated animosity against ocean research might again receive a setback. So far as I can learn on the outside, the high hopes we had had for adequate funding for ocean research under this energetic new President are being whittled down steadily by the budget officers in the Bureau of the Budget and the various departments, and that again we will come out with very little.

I will also predict that once again the Bureau of the Budget will force the departmental witnesses on S. 901 to testify that the bill is not necessary and that Senators and Congressmen will take great delight in crucifying each of these witnesses when both they and the witnesses know that the opposition stems not from the witnesses, who want the bill passed, but from the budget officers who do not.

Without wishing to comment on details of this legislation, I should like to point out the basic importance of the training programs in oceanography and the marine sciences highlighted in section 9 and elsewhere and state that the prime bottleneck in expanding the Nation's ocean research activity at present appears to be the lack of trained oceanographers.

Having made these general comments on S. 901, I would like to point out three examples of what we seek in the way of ocean research.

Eastern tropical Pacific.—Our tuna fishery was built and grew in the eastern Pacific in the area from southern California to northern Chile. In this area occur two kinds of tuna, yellowfin and skipjack. They are present in differing volumes and react differently to ocean changes and to the fishery.

The yellowfin are concentrated around the land masses, or within a few hundred miles of them, during the first 4 years of their life when they are schooled in the surface layers of the ocean and thus available to American fishermen. They are present in the eastern Pacific Ocean in finite quantity. Thanks to the researches of the Inter-American Tropical Tuna Commission, we know this quantity to be such as will produce, on a basis of sustainable yield, about 80,000 to 120,000 tons of tuna per year. Our fishing effort has now just about reached this level and is still growing. Accordingly, we can anticipate conservation regulations being applied on yellowfin fishing in the area in a short while, and we are doing what we can to make this possible when needed.

The skipjack are obviously enormously more abundant in the area than are the yellowfin. We have produced as much as 80,000 tons of skipjack in a year in the area and our fishing effort has never yet been big enough in relation to the stock of skipjack available in the area to have produced a measurable effect upon it. Obviously, the way to provide for the continued growth of the tuna fishery in the area is to shift its intensity continually onto the enormously abundant skipjack stocks.

The trouble is that the skipjack are not very cooperative. After a year or two in the surface waters reasonably close to shore where they can be located by the fishermen, they go out to sea perhaps 500, perhaps 1,500 miles from shore. There we know that they are concentrated by the ocean in various places and conditions. To put it very roughly, they appear to be concentrated in relation to the interfaces between currents, either vertical, horizontal, or sloping, where upwelling and consequent enrichment of biological productivity is present. Put even more plainly, wherever in the ocean that temperature is tolerable to them and food is most abundant, there skipjack are likely to be concentrated in sufficient abundance that you can catch a load quickly enough to get back to port and deliver your cargo at the low, prevailing prices and have a profit left.

The trick is to find out where the interface, ocean front, or food concentration is. Since the ocean currents are ever shifting over wide areas of latitude and longtitude, this is not an easy job. We have advanced in our knowledge of the ocean and the fish, however, to the point where we know that it is not an impossible task.

We know that such concentrations of skipjack may be expected, for instance, in the band of ocean between 5° and 15° north latitude and between 110° and 140° west longitude. While this is only a little piece of the Pacific Ocean, it is a big piece of water. To work this area from San Diego is perfectly feasible physically with our present fleet, the larger units of which are quite competent to make a 10,000-mile fishing trip. But to operate profitably one must locate the fish quickly, catch them quickly, and get back to port quickly.

The problem of the San Diego fisherman now is about the same as would be that of a fisherman setting out from Washington, D.C., westward, not knowing whether he could expect to locate a catchable school of tuna off Chicago, or New Orleans, or maybe off Kansas City, and with a fair chance they would be found off Phoenix or Seattle. His vessel is perfectly capable of going to any or all of these places, but if he has to spend time looking at two or three of them on one trip before catching a load, the bank will be foreclosing on his mortgage soon.

Being well aware of the limitations of the yellowfin stocks in our area, and the abundance of skipjack, we have been seeking for the past 7 years to get a program of ocean research going in this area which would provide us with the knowledge to enable us to shift economically to skipjack fishing when our fishing effort on yellowfin reached the point where it required to be limited by regulation. To date our results have been modest, and that is bragging.

Prior to the mid-1950's, the Department of the Interior had precisely no scientists working in the area of our fishery. We backed the passage of the Saltonstall-Kennedy Act in 1954 in the hopes that from this new surge of funds we could get some ocean research started by Interior in that area. We got precisely nothing.

After a White House task force from six executive departments examined our economic problems in 1955 and proposed expanded research by the Department of the Interior as one of the means to "help us help ourselves" we came very nearly getting a $300,000 a year program of ocean research started in the area. But what we actually got again was precisely nothing.

We backed the Fish and Wildlife Act of 1956 to get a program of ocean research going, among other things, and finally in 1957 the newly organized Bureau of Commercial Fisheries contracted with the Scripps Institute of Oceanography to begin research in the area It had no regularly appropriated funds for the purpose but it made a grant for beginning this research from the newly expanded Saltonstall-Kennedy funds. This made a very sound start on our problem but the iron fist of budget officers holding down the lid of expansion of appropriations for ocean research has kept this project at small size and each year has threatened it with extinction.

Our repeated economic troubles arising from cheap imports once again brought us to national attention in 1959. Again there were interdepartmental committees meeting on our problems, international negotiations carried on about them, and great planning put afoot to see that they did not recur. All hands agreed that the long-range cure for our problems lay in expanded research which the Department of the Interior was competent to do, and that about $750,000 per year was sufficient to start the job. A San Diego biological laboratory was set up for the purpose, its director hired, and a beginning made to hire staff. It looked like we were in good shape at last.

But in January 1960, when the President's budget message appeared in the public view there was again precisely no provision made in the regular appropriations of the Department of the Interior for research in our area. The only funds to be available, we were told, were from Saltonstall-Kennedy funds; they were in short supply, so unfortunately our tuna research would have to be cut back a little in 1960 rather than expanded as had been agreed in 1959 was necessary. As a matter of fact, we were told our research program would have to be cut back by at least $400,000 from the modest $750,000 program which had been agreed in 1959 was a minimum necessity.

This was the time, you will remember, when the NASCO reports were getting maximum national publicity. The President of the United States, his science adviser, the Chief of Naval Operations, Time magazine, and various others were extolling the virtues of ocean research and the need for us to hurry and catch up with the Russian effort in this respect. The predecessor of S. 901 was being launched with good fanfare and effect. Hundreds of millions of dollars were going to be spent on ocean research by the U.S. Government.

Well, budget officers do not mind the expenditure of words: they only object to the expenditure of money.

They hustled about establishing the Interdepartmental Committee on Oceanography to bring this brushfire back under their control before it became a holocaust and got some ocean research done. They shifted funds around this way and that in the budget so the public impression was created that they also were pushing hard for ocean research. But when it came to actually providing new moneys they were as niggardly as always. The Navy ocean research effort actually expanded some, chiefly due to a foresighted Chief of Naval Operations who had some strength and the will to use it. But the smaller ocean research outfits in the big agencies, such as the Bureau of Commercial Fisheries in Interior, the Coast and Geodetic Survey in Commerce, and the U.S. Weather Bureau in Commerce actually came out somewhat worse than they were before. They had new responsibilities but no money.

Our industry had one or more men in Washington, D.C., almost continuously from January to July 1960 wheedling, pleading, and conniving to get back our

$400,000 for ocean research in the eastern tropical Pacific. Thanks to the energy and persistence of Senators Engle and Kuchel, with help from their colleagues in the House, we finally got $100,000. This measly $100,000 was the first money the badly badgered budget officers of the Department of the Interior and Bureau of the Budget had ever permitted to get by their guard into the regular budget of the Department of the Interior for tuna oceanography in the eastern Pacific.

It may be noted that $100,000 will provide funds for keeping at sea a small ocean research vessel for about 100 days or a 3-month cruise (which, until recently, has been the normal length for a tuna clipper single fishing trip in this area). It will not provide for any research of consequence. It will only put a platform out on the ocean for one trip a year where the scientists could do some research, if there were any scientists and if they had any instruments.

As a matter of fact, the Bureau of Commercial Fisheries has never had an oceangoing research ship of its own with which to work in the eastern tropical Pacific. During this very period of time, it has had to get rid of its *Manning* which worked out of Honolulu, for lack of funds. It has had to get rid of its *H. M. Smith* which worked out of Hawaii, for lack of funds. It has had to stringently limit its use of the old yacht *Black Douglas* (which did work offshore in California) for lack of funds.

Thus, we have been steadily sliding backward on actual fisheries ocean research vessel capabilities in the Pacific, while the hue and cry for expansion has been in full voice.

As we have grown to expect, the Department of the Interior budget for fiscal 1962, when revealed this January, once again provided precisely no new funds for ocean research operations in the eastern Pacific, or at all. Accordingly, we were in to see Senator Engle, Senator Kuchel, and the new Secretary of the Interior, seeking our still missing $300,000 from the 1959 promises before January was out, and we propose to pursue this effort with what vigor we have.

In the meantime, it has occurred to the Department of the Navy, the Department of Defense, the Atomic Energy Commission, the U.S. Weather Bureau and various other entities, that the eastern tropical Pacific, where all these skipjack tuna are purported to be, is also the western approach to the Panama Canal. Amongst other things, it has been found that you need reasonably the same kind of information about the ocean with which to locate and catch submarines as you do to locate and catch skipjack; that you need to know how the currents go if you are going to dump nuclear wastes into the ocean without sterilizing it; and that tropical hurricanes are borne in the tropical eastern Pacific, as elsewhere in the Tropics, and seldom seen except by tuna boats before their destructive force suddenly hits land.

Accordingly, last winter the Eastern Pacific Oceanic Conference set up a committee among all the Government and university scientists involved to draw up a competent program of ocean research in the eastern Pacific to accommodate all these needs. The area to be covered is roughly bounded by 30° north latitude, 20° south latitude, 140° west longitude, and the coasts of the Americas. It is somewhat larger than the United States. The scope of the plans and the breadth of U.S. interest in the area is set out in the report of the chairman of this committee's first meeting which is attached hereto as appendix I.

This is the area of the world ocean which holds first priority for us in ocean research for reasons noted above. Most of the research stations in the area up to now have been occupied by our ocean scientists, more often than not with funds that have been more or less stolen from other parts of the Federal budget in ways the budget officers could not regularly detect and block, for we have all learned a little over the years from watching them. We are most happy that this area is now rising high on the priority of the Navy, Atomic Energy Commission, and others. We will cooperate with anybody who has new money to spend on ocean research in this area.

California Current.—About 20 years ago the California sardine began to decline in abundance. This is not an unusual phenomenon with the herringlike fishes. It has happened off Japan, off South Africa, off western Europe, and everywhere that important sea fisheries for this sort of fish occurs. Records of sorts over a 1,200-year period in the great herring fisheries of the Norwegian Sea show long period cycles of waxing and waning of fish abundance occupying a generation or more of man.

Yet the reason for these changes in abundance are not well understood, their predictability is impossible or inexact, the relation between them and the fishing activities of man as well as modifications in ocean climate is more hypothetical than based on serious research findings.

With these things in mind, the California sardine industry in the late 1940's instigated the establishment of a coordinated ocean research program in the California Current area with a view to elucidating the physical, chemical, and biological processes which led to variations in the abundance and availability of sardine in that area. It secured the cooperation of a working committee of scientists from the several research agencies involved. It secured the passage of legislation which established a marine research committee in the State government and provided it with a $1 per ton new catch tax to spend on the research. It secured the establishment in the University of California budget of an item to found a marine life research project at the Scripps Institute of Oceanography. It secured the cooperation of the sardine investigations of the Department of the Interior, and of the State department of fish and game. It enlisted the support of the Hopkins Marine Station of Stanford University and the California Academy of Sciences.

In this way and beginning actively at sea about in 1948, the marine research committee (an official State body appointed by the Governor), aided and abetted by an advisory committee of scientists called the California Cooperative Fisheries Investigation Committee (CALCOFI), which had no formal or legal status, began the investigation of the ocean within about 500 to 1,000 miles of California with a view to finding out what was happening to the sardine and why. These two groups had from $1 million to $1,250,000 per year to spend for this purpose.

After the passage of 12 years and the expenditure of about $15 million on well-planned, highly integrated, comprehensive research in this rather small piece of ocean, one may say without fear of contradiction that, with the possible exception of the North Sea where competent general ocean research has been going on for more than three times as long, no segment of the world ocean is as well known or as well understood as is the California Current.

Yet, with the close of the 1950's and nearly 12 years of intensive research, both the marine research committee and its related CALCOFI committee found themselves dissatisfied with their work, its organization, its scale of funding, and its results Despite the admittedly great results in understanding that had been achieved, it seemed as if they were only a springboard or a jumping off place for initiating a real investigation of ocean processes so that a real understanding of them could be achieved.

Despite what appears even in these days of big oceanography talk quite a bit of money for investigating a small piece of ocean, the steady inflation of costs during the decade mean that $1 million would buy only about half as much research in 1960 as it did in 1950, and belts had to be tightened all the way around The steadily shrinking true value of the research dollar meant that increasing quantities of the most valuable sort of data and specimens had to be stored away in closets and basements because funds were not available to hire scientists to work them up. Thus, perhaps more than half the results of $10 million worth of research ship time lay on shelves gathering dust. While everything seemed to be fully coordinated and well planned, it was obvious that organization, as well as belts, needed to be tightened.

The marine research committee thus began a thorough and searching investigation of itself and its works and came away from this examination less than satisfied. Upon the recommendation of its scientific collaborators, it hired a top scientist to coordinate it and their work, and it formally established the CALCOFI committee to be composed of this coordinator as chairman and the head scientist of each of the three principal collaborating laboratories as members. The newly formalized CALCOFI committtee began a complete revaluation of the objectives of this program of research dollars, and presented this rather radically, newly oriented program to the marine research committee for its consideration.

The MRC examined this new program, found it good, adopted it and allocated what funds it had to put it afoot.

Having done this much by the end of 1960, the marine research committee found itself still profoundly uneasy and dissatisfied. It had reason to believe its collaborating scientists were as competent a group as any in the world, that their accomplishments had been large with respect to moneys that had been spent, and that their present program of investigation was well conceived for the economic use of the research dollars expended.

Yet, with new understanding of the ocean had come new realization of basic ignorance about it. New demands for further understanding had come from the burgeoning salt water sports fishery, the State beach erosion board, the State pollution board, the climatologists who worried about the amount of ocean desposited as snow in the Sierras each winter which kept this mostly desert State alive during the rest of the year, the Atomic Energy Commission that wanted safe places to dispose of its wastes, the merchant shipping people who wanted to know about waves and storms, the Navy that wanted to know about everything, and a dozen other entities who had come to use the ocean newly or more fully.

The marine research committee was after all a creature of the commercial fishing industry. It did not claim to be all knowing about the ocean. It was paying most of the cost of all the basic ocean research in the area to the point where its own most desired research projects were suffering from want. New customers for ocean understanding which it had neither solicited, wanted nor very well understood, were clamoring for new ocean understanding which needed new research money to gain, and they were chipping nothing into the research pot except complaints.

Accordingly, the marine research committee of the State of California has recently taken two more steps which it hopes will be far-reaching:

(1) It has directed its chairman to ask the Governor of California to convene, or cause to be convened, a competent ad hoc committee of scientists and administrators to examine into, and program for, all the needs that the State of California has and may soon have in the way of knowledge about the neighboring ocean and its inhabitants.

It has suggested that the Governor consider the advantageousness of soliciting the National Academy of Sciences to make available its committee on oceanography, or a competent panel thereof, for this purpose for two reasons: (*a*) That the State's program of ocean research be fully integrated with the Nation's program; and (*b*) that the same high competence used by NASCO in its Federal programing can be brought to bear upon the similar if smaller State problems.

(2) Having decided to do this and knowing that useful results could not be anticipated from this request for some time to come, the marine research committee decided to cast caution aside and design its research program on a larger scale than it could itself fund, in the hopes that if it designed a suitable program of expanded ocean research for the area it could talk some of its new and unsolicited customers into chipping a few research dollars into the pot and bearing part of the new research load they demanded.

With this in mind the marine research committee requested its CALCOFI committee to forget for the time being all budgetary restrictions and design for it a comprehensive program of research for the California Current which would wring all useful knowledge and understanding possible from the dust-catching stocks of data and specimens on the shelf and designed to inquire comprehensively, and not just fisherywise, into the processes of the California Current.

After years of tight budgetary controls, this competent group of scientists found it difficult to throw of the shackles of small thought which this had put upon them. Accordingly, the first draft of their report fell well short of what the committee had in mind. Accordingly, the marine research committee gave them an A for effort and asked them to try again.

The CALCOFI group did try again and did considerably better this time. It submitted a list of suitable projects underway at present and desirable new projects for which new funding would be necessary, under four headings: Surveys, Sardine Research, Capital Expenses, and Utilization. The program called in total for about $1,250,000 of new capital expenses, and a little less than $1 million per year of new operating money for the next 5 years.

The marine research committee felt that this new program came a good deal nearer to what it had in mind, although it was admittedly an incomplete program and the fourth section, "Utilization," had received so little close thought that it was merely sketched in. A copy of this second, tentative draft of a new marine research committee program of investigating the California Current area is attached for your background information. It does not purport to be either complete, adequate, or finished.

This new program was sufficiently satisfactory that the marine research committee tentatively adopted the first three sections of it (surveys, sardine research, and capital outlay), so that efforts could be initiated to seek the new funding at once. The committee then asked CALCOFI to rework the whole thing again with a view to having a competent, comprehensive program of research available for the next meeting of the marine research committee in early June.

This is the second area of ocean research priority of the California fishing industry. Unlike the first priority area of the eastern tropical Pacific where new and added data are perhaps the great need, in this second area abundant unworked data are already on hand and what is needed perhaps most is not new data but new understanding. One might say that the prime component of the eastern tropical Pacific area problem is survey, while the prime component desire in the California Current area is research.

In both areas it may be noted that while the fishery people are the prime promoters and have been to date the prime doers of the basic ocean research, we are not any longer the largest or most important users of the research results. Accordingly, we hope and intend that the new users will begin to feel uncomfortable if they don't start picking up their share of the tabs. At least we intend to work in that direction.

West Africa.—The third example of ocean research which we wish to call to your attention lies in the area of the eastern Atlantic from Morocco on the north to Angola on the south, and perhaps 1,000 miles to sea from the African coast.

In the northern section of this area, along the coast of Morocco and Mauritania, considerable trawl fisheries are beginning to be developed by the French, Spanish, Portuguese, Italian, Greek, Israeli, and Tunisian vessels. To the south of this already large tuna fisheries are being developed by those countries, the Japanese, Nationalist China, the United States, and Norway. Off the coast of Ghana substantial sardine fisheries are being developed by the Russians, Poles, and East Germans.

Leaving aside for the moment the fishermen of all of these industrially developed peoples, one must look at the situation of the numerous new nations of Africa which border on this section of sea.

Running from Gambia on the west through the Cameroons on the east into the Congo, and central Africa is a belt of dense rain forest. In this jungle live some 50 to 60 million Africans. There also lives the tse-tse fly which carries diseases and makes the cultivation of domestic food animals inpracticable, and game animals scarce. These Africans depend consequently for the protein part of their diet upon dried and smoked fish. Their richly productive inland waters do not produce enough for their sustenance. They import large quantities of dried fish from other countries with foreign exchange they cannot afford to spend. The individual inhabitants are poor and cannot in many instances afford to buy enough of even these poor products to more than maintain life. Protein deficiency to some degree is the normal lot of most of these Africans all of their life and the dreaded protein deficiency disease "Kwashiorkor" is one of the larger contributors to the abnormally high childhood death rate in the area.

Directly offshore from this weltering mass of poorly fed people is one of the most productive sectors of the world ocean, producing precisely the sort of food which the people ashore both need and want. So far as they are concerned the fish may as well be on the backside of the moon because you can't harvest high seas fishery resources with hand-paddled or sail-driven dugout canoes with enough efficiency to feed many people very long or very well. But this is the only sort of vessel these people have or know how to use.

The Russians discovered all of this about the same time we did and with characteristic efficiency began bending these factors of human misery and opportunity to their diplomatic profit. The Poles have now undertaken to provide Guinea with a modern fishing industry; the Russians, according to our trade information, are considering doing the same for Ghana. It is not an unrelated fact that Guinea appears to be lost to the free world and that Ghana, at the very best, appears to be on the fence. Our best trade information leads us to believe that the United States and the free world has between 18 and 24 months to demonstrate its good will and the efficiency of our way of government and doing business to these newly originated nations and thus keep them from drifting behind the Iron Curtain.

We are fish people. We do not purport to be diplomats, but we do get around the world a good bit and watch what is going on. In our humble opinion, the United States could do much in the next 2 years to win friends in West Africa by showing these people how to get the fish out of the nearby ocean that they so badly need in their bellies. At the risk of immodesty, we do not think there is anything the Russians can do about harvesting the sea that the combined talents and energy of the U.S. Government and the U.S. fishing industry cannot do better.

With this in mind we have brought these matters to the attention of Mr. Henry Labouisse, the new Administrator of the International Cooperation Administration, and to Gov. G. Mennen Williams, the new Assistant Secretary of State for African Affairs, by means of the attached letters and by personal conversations with them and their staffs. We are prepared to do anything we appropriately can do to aid the U.S. Government should it decide to embark upon any of these ventures.

The pertinence of this to the present bill is that one of the main things these African countries want is a competent, comprehensive, joint fisheries-oceanographic survey of the seas off this coast. They want this quickly. They want this so badly that they do not care whether they get it from East or West. I have been told this personally by officers of these governments who are not presently unfriendly to us. The question is can the U.S. Government move as swiftly into this situation as the Russians can. Nothing I have seen or heard in the last 3 months leaves me sanguine.

Nevertheless, we put this ocean-fish survey off West Africa in our third rank of priority. In doing so I wish to point out clearly that we expect little or no benefit from it to ourselves. We know where the tuna are in the area that we want. We have two companies and five vessels in the area working on an experimental basis at the present time. If these operations yield a profit, as we expect, we will move in more heavily no matter what the U.S. Government does in these matters; if they do not yield a profit we will move out.

As a matter of fact, we can only expect some damage to come to us from having brought these matters to the attention of the Government because it will probably only serve as a new excuse for the budget officers of Interior and the Bureau of the Budget to hold down the development of ocean research in the eastern Pacific where it would help us. Nevertheless, these suggestions on fishery activity by the United States in west Africa make too good diplomatic sense for us not to suggest them.

Having said all this, we once more say that we are strongly in favor of the passage of S. 901 in its present form and will do what we can to help it.

If I have said anything that is offensive to Budget officers as a group or was inclined to imply that they have exercised extreme myopia in their handling of the Nation's ocean research interest, it was because I meant to. I am reminded of a comment recently made to me, in no confidence, by a highly placed officer of the U.S. Navy. His comment was that if the Department of State could induce the Russians to adopt the budgetary system of the U.S. Government, our expenditure for Polaris and other weapons systems could be made a good deal less.

APPENDIX I—CHAPMAN STATEMENT

U.S. DEPARTMENT OF THE INTERIOR,
FISH AND WILDLIFE SERVICE,
BUREAU OF COMMERCIAL FISHERIES,
BIOLOGICAL LABORATORY,
San Diego, Calif., March 3, 1961.

To All Members: EPOC (Eastern Pacific Oceanic Conference), Committee on a Cooperative Program of Study of the Eastern Tropical Pacific Ocean.

GENTLEMEN: The first meeting of the EPOC Committee on a Cooperative Study of the Eastern Tropical Pacific Ocean was held in Mr. John Isaacs' office at Scripps Institution of Oceanography on February 17, 1961. Attached is a copy of the minutes of this meeting. Those of you who were not present are entitled to a word of explanation since you were not advised of the meeting.

After Dr. Sette, EPOC chairman, notified me that he had invited each of you to serve on this committee, I thought that it would be useful to call a meeting immediately. I saw difficulty in being able to get us all together within any reasonable time and felt that, since our report is due in September 1961, we should get started immediately. Therefore, I called together the members resident in the San Diego area.

You will recall that Dr. Sette advised you that I had agreed to serve as chairman pro tem to convene this committee. Members present at our first meeting asked that "pro tem" be dropped. I have agreed to serve as chairman with reluctance because I am also chairing another EPOC committee; however, I will do so unless one of the absent members will care to volunteer. Bert Bennett will serve as secretary.

You will note from the minutes that we adopted a procedure for developing the proposed program and that we each have work to complete before our next meeting which is set for as soon after April 15 as possible but before May 1. Could you advise me as to what date is most convenient and whether you will be able to attend a meeting in San Diego or Los Angeles. It is important that as many of us as possible be present at the next session.

I shall also be interested to know if our Washington, D.C. and Monetery colleagues have plans to visit southern California during the next few months, so that we may schedule a committee meeting to coincide with their visits. It does not seem feasible to schedule meetings anywhere but in San Diego or Los Angeles.

I request that each of you prepare the statements as outlined in the minutes as quickly as possible and that you make every effort to see that copies reach the secretary and the other members not later than April 10, 1961. By this means, we will have the opportunity to review each other's requirements prior to our next meeting.

Please use the guide list of needs and wants in preparing your statement so that integration into an overall picture of needs and wants will be easier.

I hope that we will be able to do a good job.

Sincerely,

GERALD V. HOWARD, *Chairman.*

EPOC COMMITTEE ON A COOPERATIVE PROGRAM OF STUDY OF THE EASTERN TROPICAL PACIFIC OCEAN

Minutes of the initial meeting held at Scripps Institution of Oceanography on February 17, 1961

Members present: G. V. Howard, USBCF, chairman; E. B. Bennett, IATTC, secretary; E. C. LaFond, USNEL; R. S. Arthur, SIO; W. M. Chapman, TRC; J. D. Isaacs, SIO.

Members absent: M. B. Schaefer, IATTC; J. B. Bjerknes, UCLA Met.; C. N. G. Hendrix, USNHO; G. W. Kalstrom, USWB; P. M. Wolff, NANWEP (Monterey); Dr. H. J. Stewart (C. & G. S.).

The committee noted that, although each member is from a research group which has interest in the eastern tropical Pacific Ocean, the members are not officially representing their organizations.

The question of participation of individuals from other groups in the committee was discussed. In particular, the overlapping of parts of the AEC proving ground and "the eastern tropical Pacific" (defined below) was indicated. Moreover, the AEC, although interested in a cooperative study, probably would not be able to contribute directly to the study. It was proposed that scientists from such groups might be called upon for advice and assistance as required but that the committee should not be enlarged.

Because of the diverse committee membership and the fact that the committee report must be presented to the EPOC in September 1961, it was felt that there was little hope of ever having a full committee meeting and that each meeting would probably have a different group of members. A solution to this problem will be explored, however, in the hope of having at least one full committee meeting in the summer. In any case, notices of future meetings will be circulated well in advance.

The eastern tropical Pacific was defined as that part of the ocean bounded by 30° N., 20° S. and by 140° W. and the west coastlines of the Americans, but this definition of area of interest was not meant to exclude the atmosphere above the ocean nor the sediment structure in the sea bottom. There was some discussion of the extent and quality of previous studies in the area with the result that a summary of previous and continuing activities is to be prepared by the secretary and distributed to the committee before its next meeting. It was considered desirable to have a coordinated study of the eastern tropical Pacific because—

(1) the United States would gain prestige from a well-planned, well-executed cooperative study of a large ocean area;

(2) it is expected that recommendations of NASCO will stimulate action in the U.S. Congress to provide increased support for oceanographic research and that priority will be given to properly planned programs which will meet the needs of a broad spectrum of research interests;

(3) each research group now interested in the area cannot afford to undertake singly a program of necessary magnitude;

(4) the area is key—even unique—in many aspects and such a program would satisfy much of man's need for knowledge about tropical areas;

(5) the western part of the area is essentially free of emergent landforms so there would be an opportunity for studying the ocean in the absence of rigid lateral boundaries.

That EPOC should formulate a proposed program was reaffirmed. The influence of EPOC in the establishment of the national data center, the organization of Eastropic and other expeditions, and other matters was noted.

Because of the probability of never having a full committee meeting and because of the limited time before the September 1961 EPOC, the following procedure was adopted for developing a proposed program:

(1) Committee members should be asked to provide background information to reflect—

(*a*) a realistic estimate of research proposed by their organizations in the eastern tropical Pacific during the next 2 (1961–62) years and the facilities available (people, ships, money);

(*b*) additional research and facilities, beyond that outlined in (*a*) which they consider necessary to meet the needs and wants of their organizations;

(*c*) research their organizations could or would like to do in the eastern tropical Pacific, and the additional facilities needed, if neither (*a*) nor (*b*) is applicable.

(2) Committee members be asked to send a copy of the solicited information to the secretary and to each committee member at least 1 week before the next meeting (April 10 requested in chairman's letter).

(3) At the next meeting the committee could proceed to develop a proposed program based on the needs and wants of the various research interests, having in mind the facilities available and additional ones required.

A guide list of needs and wants was prepared. A desirable program was considered to be that which would provide knowledge of—

(1) the general circulation;
(2) the relationship between ocean and atmosphere (implies a rather large meteorology program);
(3) water motion at various depths;
(4) oceanic fronts;
(5) eddies;
(6) water mass boundaries;
(7) the surface layer;
(8) internal waves;
(9) mechanisms of accumulation of commercial fishes;
(10) zoogeography;
(11) phytogeography;
(12) sound velocity structure;
(13) disruption of acoustic detection (scattering, etc.);
(14) sedimentation;
(15) penetration of light.

In addition the program should provide knowledge of fluctations, and of the factors controlling fluctuations, in these items. Additional observations should be made to describe—

(16) bathymetry;
(17) sediments;
(18) sound penetration of sediments;
(19) acceleration of gravity;
(20) magnetic intensity.

The difference between "pattern research" (surveys) and "specific research" (individual research) was discussed. It was noted that—

(1) Any pattern research should be planned to get data usable for specific research;

(2) Specific research cannot always be planned ahead;

(3) In general, most pattern research programs will satisfy in part the research needs or wants of all groups.

It was noted that there are two kinds of pattern research:

1. Surveys of the bathymetry or magnetic intensity need be done only once but each requires a high density of observations.

2. A monitoring program requires continuous on continual observation at a relatively few number of observation points.

The question of how much of each kind of research should be included in the program (both in time and space) was left to the next meeting.

It was noted that the development of a cooperative study is good because each group can lend support to the program. It was further noted, however, that, in the final analysis, individuals will utilize the data.

It was agreed that, when the committee develops a proposed program, this should first be done without regard to cost of the program.

The establishment of an electronic navigational aid system, such as one of the English systems, was recommended for the area of interest. Successful establishment by NASA of satellites as a navigation system was considered to be doubtful for several years. Because of the vital need for a good navigation system, the recommendation is to be considered separate from the development of a proposed program of study.

EDWARD D. BENNETT, *Secretary.*

ADDRESSES OF COMMITTEE MEMBERS

Dr. R. S. Arthur,[1] Scripps Institution of Oceanography, La Jolla, Calif.
Mr. E. B. Bennett, Inter-American Tropical Tuna Commission, c/o Scripps Institution of Oceanography, La Jolla, Calif.
Prof. J. B. Bjerknes, Department of Meteorology, University of California, Los Angeles, Calif.
Dr. W. M. Chapman, The Resources Committee, 1 Tuna Lane, San Diego, Calif.
Capt. C. N. G. Hendrix, U.S. Navy Hydrographic Office, Washington, D.C.
Prof. J. D. Isaacs,[1] Scripps Institution of Oceanography, La Jolla, Calif.
Mr. G. W. Kalstrom, Forecast Center, U.S. Weather Bureau, Los Angeles International Airport, Los Angeles, Calif.
Dr. E. C. LaFond, U.S. Navy Electronics Laboratory, San Diego, Calif.
Dr. M. B. Schaefer,[2] Inter-American Tropical Tuna Commission, c/o Scripps Institution of Oceanography, La Jolla, Calif.
Dr. H. B. Stewart, U.S. Coast and Geodetic Survey, Department of Commerce, Washington, D.C.
Commander P. M. Wolff, Project NANWEP, U.S. Navy Postgraduate School, Monterey, Calif.
Mr. G. V. Howard, chairman, Bureau of Commercial Fisheries, Post Office Box 6121, Point Loma Station, San Diego, Calif.

APPENDIX 2—CHAPMAN STATEMENT

UNIVERSITY OF CALIFORNIA, SCRIPPS INSTITUTION OF OCEANOGRAPHY,
La Jolla, Calif., February 28, 1961.

Re new CALCOFI program:

Marine Research Committee:

The attached second draft of an expanded CALCOFI program is herewith submitted to you for consideration. We do not regard it as complete, but we do feel that it embraces many of our most pressing needs.

Three notes of caution are in order. One refers to costs. These have been made as realistic as possible, but clearly cannot be regarded as final working budgets. The second refers to space. We have assumed that space is, or will be, available, but cannot certify that this is so.

Finally, and this cannot be overly emphasized, we cannot certify that our parent organizations would be willing to accept these new responsibilities even if you approve them and find the money. There has simply not been enough time to carry all of the new projects through the elaborate policy and guidance mechanisms of the various organizations. We do certify all of them to you as sound, desirable, and scientifically feasible.

Sincerely,

GARTH I. MURPHY, *Chairman, CALCOFI Committee.*

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[1] Joint alternates from SIO.
[2] Alternate for Mr. E. B. Bennett (IATTC).

SUMMARY OF PROGRAM OF FEB. 27, 1961

Project No.	*Title*	*First year cost*
1.0.0.0	General Understanding of California current system:	
1.1.0.0	Surveys, SIO, C.F. & G., BCF, Hopkins	$720,000
1.2.0.0	General research:	
1.2.1.0	Existing studies:	
1.2.1.1	Oceanography analysis and atlas preparation, SIO	65,000
1.2.1.2	Zoogeographic studies, SIO	40,000
1.2.1.3	Marine genetics, SIO	25,000
1.2.1.4	Ecology and physiology of marine algae, SIO	15,000
1.2.1.5	Exploratory studies, SIO	45,000
1.2.1.6	Marine vertebrate studies, SIO	28,000
1.2.1.7	Research vessel time, SIO	60,000
1.2.1.8	Studies of fishes ecologically associated with sardines BCF	20,000
1.2.1.9	Fecundity of sardines and other fishes, BCF	8,000
1.2.2.0	New general research projjects:	
1.2.2.1	Monograph of eggs and larvae, BCF	50,000
1.2.2.2	Quantity assay of zooplankton, BCF	28,000
1.2.2.3	Comparative analysis of California current system, SIO	60,000
1.2.2.4	Energy budget of California current system, SIO	25,000
1.2.2.5	Coastal dynamics of California current system, SIO	230,000
1.2.2.6	Bioassay of organic nutrients, SIO	30,000
1.2.2.7	Relations between Marine Organism and environment, SIO	10,000
1.2.2.8	NE Pacific radiolaria, SIO	14,000
1.2.2.9	Transparency of California current, SIO	15,000
1.2.2.10	Additional General zoogeography, SIO	45,000
2.0.0.0.	Research on sardine:	
2.0.1.0	Existing research:	
2.0.1.1	Annual investigation fishery, C.F. & G	40,000
2.0.1.2	Dynamics of sardine, C.F. & G	8,000
2.0.1.3	Behavior of sardines at sea, C.F. & G	26,000
2.0.1.4	Sub populations of sardines, C.F. & G	20,000
2.0.1.5	Population Dynamics of sardine, BCF	48,000
2.0.1.6	Age and growth sardines, BCF	16,500
2.0.1.7	Availability and behavior, BCF	46,800
2.0.1.8	Genetic analysis of population, BCF	7,000
2.0.1.9	Physiology of sardines, BCF	21,000
2.0.1.10	Laboratory studies of behavior, CAS	7,500
2.0.2.0	New research on sardine:	
2.0.2.1	Reduction of back data, C.F. & G	25,000
2.0.2.2	Relation Larval Survey to Environment, SIO, BCF	30,000
2.0.2.3	Comparative study food of pelagic fishes, C.F. & G	13,000
2.0.2.4	Survey of wet fish fishery, C.F. & G	22,000
2.0.2.5	Restudy of age and growth, BCF, C.F. & G	14,000
2.0.2.6	Rearing pelagic fishes, BCF	165,000
2.0.2.7	Summary population data, C.F. & G., BCF	25,000
2.0.2.9	Summarize species interrelations, BCF, C.F. & G	10,000
3.0.0.0	Capital expenses:	
3.0.0.1	Oceanographic vessel (conversion), SIO	400,000
3.0.0.2	Underwater camera, SIO	13,500
3.0.0.3	Computer center, C.F. & G	101,500
3.0.0.4	Fisheries oceanography vessel, C.F. & G	750,000
4.0.0.0	Utilization research (unspecified):	
4.0.1.0	Phase one:	
4.0.1.1	Availability survey	100,000
4.0.1.2	Utilization elsewhere	50,000
4.0.1.3	Collation and preliminary estimates	50,000
4.0.2.0	Phase Two—Application research	
4.0.2.1	Application research	200,000
	Total	400,000

SUMMARY

Project No.	Title	First year cost
1.0.0.0	General Understanding:	
	Surveys (expanded by 185,000)	$720,000
	Existing research	306,000
	New research	507,000
	Total research	813,000
2.0.0.0	Sardine research:	
	Existing research	240,800
	New research	304,000
	Total research	544,800
3.0.0.0	Capital expenditures	1,265,500
4.0.0.0	Utilization research:	
	Phase 1	200,000
	Phase 2	200,000
	Existing program:	
	Surveys	535,000
	General research	306,000
	Sardine research	240,000
	Total	1,081,000
	Expanded program:	
	Surveys	720,000
	General research	813,000
	Sardine research	544,800
	Total	2,077,800
	Deficit	996,800
	Utilization:	
	Phase 1	200,000
	Phase 2	200,000
	Capital expenses	1,265,500
	Maximum first year new money	2,462,300

[2d Draft—February 27, 1961]

Prospectus for an Expanded CALCOFI Research Program

(By CALCOFI Committee)

This document represents a reorganization, and proposed expansion of the program of surveys and research sponsored and coordinated by the Marine Research Committee of the Department of Fish and Game, State of California. The objectives of the program have been most recently stated as—

> "To acquire knowledge and understanding of the factors governing the abundance, distribution, and variation of the pelagic marine fishes. The oceanographic and biological factors affecting the sardine and its ecological associated in the California Current system will be given research emphasis. It is the ultimate aim of the investigations to obtain an understanding sufficient to predict, thus permitting efficient utilization of the species, and perhaps manipulation of the population."

It will become apparent that if the program that follows is adopted some revision of these objectives will be required, especially as regards conducting research designed to translate the results of the basic research into information directly usable by the public. Obviously, such a policy decision cannot be made without considerable consultation among and within the various agencies.

The projects are organized by major groupings associated with major objectives. Existing and currently funded projects are listed first, followed by listings of new proposal. These are presented briefly. Fuller descriptions including details of the plans are available and can be furnished as requested.

1.0.0.0. Acquisition of general understanding of the California Current system and its inhabitants

This is the basic foundation of the CALCOFI program. It develops the background information necessary to understand the sardine and its associates. Because it is basic, the information is equally applicable, or can be so made, to all other fish species, pollution problems, military problems, etc.

1.1.0.0. Surveys (Project 1).—This is the basic survey of the California current system. It includes physical and chemical oceanography and plankton (including fish eggs and larvae) and juvenile and adult fishes. Continuation of this work is envisioned as necessary into the indefinite future though the operation will be subject to revision as new tools such as anchored stations become fully available.

If the present program is expanded to provide adequate information for all users in the waters of the State it will be about one-third larger.

The costs given below include field operations, and processing of the data to the point that particular analyses will require differing treatment.

Scripps Institution of Oceanography	$320, 000
Bureau of Commercial Fisheries	102, 000
Hopkins Marine Station	8, 000
California fish and game	105, 000
Total	535, 000

Enlarging the scope of this survey will raise the cost to about $720,000.

This basic survey is the portion of the program that should be funded on a broader base than the wet fish resources. Logical sources are State general funds, sport and commercial license funds: AEC, U.S. Navy, NASCO funds, and Bureau of Commercial Fisheries funds.

Coincident with refunding the program, a guidance committee comprised of all important users should be created, their initial task being to develop the most broadly useful survey consonant with the funds available.

1.2.0.0. General research.—This includes research that, as in the instance of the surveys must be done to understand the sardine, but which produces results of general application. This research is also susceptible to broader funding, especially on a project-by-project basis. However, this tack will tend to cause the CALCOFI program to lose coherence and direction, and for this reason alone it would be most desirable to refinance large coherent blocks of work such as the surveys.

1.2.1.0. Existing general research studies.—These are research programs at present funded at a reasonable level considering their relative importance, and the possibility of orderly expansion.

1.2.1.1. Oceanographic analysis and atlas preparation.—This includes further processing of the marine life research data and preparation of atlas charts of the California Current system data. In addition it includes studies of heat budgets, statistical prediction systems in the California Current region, and general, and descriptive analyses of the oceanography of the North Pacific.

Scripps Institution of Oceanography	$50, 000
Additional funds needed for atlas publication:	
First year	15, 000
Second year	25, 000
Third year	25, 000

1.2.1.2. Zoogeographic studies.—These are studies of the various components of the plankton. The initial aim is to understand the existing general distributions and species compositions. To meet this objective it is necessary to consider the larger North Pacific circulation of which our area of interest is but a part. Studies are underway on copepods, chaetognaths, and other groups. In addition, preliminary studies of associations and boundaries have been initiated.

Scripps Institution of Oceanography cost	$40,000

1.2.1.3. Marine genetics.—This work will be funded in other ways in the near future. It is included here only to complete the recording of present costs.

Scripps Institution of Oceanography cost	$25,000

1.2.1.4 Ecology and physiology—of marine algae.—This includes general support of marine botany research as well as specific projects such as monitoring the species composition and abundance of phytoplankters in the waters off Scripps Institution of Oceanography, and analysis of historical samples.

Scripps Institution of Oceanography annual cost---------------------- $15,000

1.2.1.5. Exploratory studies.—This includes a wide number of studies and tests of improved observations and methods, and analyses of data. This covers improved nets, direct current measurements, investigations into the efficacy of nets and escape of organisms, inquiry into the interpretation of sardine larvae catch data, etc.

Scripps Institution of Oceanography (continuing) annual cost--------- $45,000

1.2.1.6 Marine vertebrate studies.—This project includes general support of systematic studies in the Pacific as well as specialized studies of the races of sardines.

Scripps Institution of Oceeonography annual cost--------------------- $28, 000

1.2.1.7 Vessel time.—Vessel time for project 1.2.1.1–1.2.1.6.

Scripps Institution of Oceanography annual cost---------------------- $60, 000

1.2.1.8 Studies of fishes ecologically associated with sardines.—At present this includes systematic studies and studies of larval development.

Bureau of Commercial Fisheries annual cost------------------------ $20, 000

1.2.1.9 Fecundity of sardines and other fishes.—A general study of fecundity with the objective of understanding the sardine, but necessarily conducted on a broad basis.

Bureau of Commercial Fisheries annual cost-------------------------- $8, 000

1.2.2.0 New General research projects.—These are projects either not now funded, or funded at such a low level they require substantial new resources to bring them to a satisfactory level.

1.2.2.1 Monograph of eggs and larvae of pelagic fishes of the California Current system.—Material is available at the La Jolla Laboratory, Bureau of Commercial Fisheries, on which to base a monographic treatment of the eggs and larvae of the California Current system.

During the 12-year period, 1949–60, the La Jolla Laboratory of the Bureau of Commercial Fisheries has built up the most extensive larval fish collection in the United States and perhaps in the world.

The material has been obtained from plankton collections in the CALCOFI area, which have averaged between 1,500 and 2,000 a year. Upwards of 20,000 collections have been made in the CALCOFI area. In addition, more wide ranging expeditions such as Norpac, Northern Holiday, Shellback, and Scot have extended the distributions of many of the species. Seven cruises have been made in the Gulf of California.

Bureau of Commercial Fisheries annual cost (3 years)--------------- $50, 000

1.2.2.2 Quantitative assay of zooplankton constituents.—During the past 12 years, cruises undertaken under the CALCOFI program have collected approximately 2,000 plankton samples a year. Collecting of plankton samples will continue in future years at a reduced rate—perhaps 1,000 samples per year. The collections represent the most thorough coverage of an era ever attempted.

Plankton volumes have been determined and made available in a series of data reports, published in the Bureau of Commercial Fisheries Series; Special Scientific Report—Fisheries. Individual groups of organisms have been studied at Scripps, including euphausiids, salps, doliolids, pelagic annelids, pteropods, arrow worms, siphonophores, mysids, amphipods, and copepods. Studies to date have been mostly taxonomic and geographical studies of particular groups of plankters. Little or no attention has been paid to the quantitative role (especially the volumetric contribution) of the different constituent groups. The proposed projects would fill this hiatus.

Measurements of total plankton volumes are of limited value, principally because marked increases in volumes result from increases in jellylike organisms that have little value as food for other organisms. Crustacean plankton constituents probably have as high a nutritive value as any group of plankters. Hence in assessing the nutritive potential of a standing crop of zooplankton, it is important to have quantitative information on the major constituent groups. So far such measurements are available only for a limited number of plankton samples from the eastern North Pacific.

Volumetric measurements are preferable to counts of individuals. Constituent measurements can be made by group (euphasiid, copepods, salps, etc.) and, where warranted, by the major species making up each constituent group.

The information is needed in evaluating the potential of the standing crop of zooplankton, in food studies of plankton feeding fishes, and in studies on the success of survival of year classes of fishes.

Bureau of Commercial Fisheries annual cost (3 years)---------------- $28, 000

1.2.2.3 Comparative analysis and history of the California Current system.—This program will have two interrelated objectives, as follows:

A. To compare the present research period (1949 to present) with the modern data period (1912–49), and

B. To place these two periods in perspective with the long-term record of the California Current system.

A. Modern data period (1912–49)

It has been said that a high priority of the CALCOFI research is to discover if possible, the basic causes of the catastrophic change of sardine abundance and distribution that occurred in the 1940's.

Thus the first part of this program will extrapolate our present understanding of the ecology of the California Current system back to the beginnings of modern weather, fisheries, and oceanographic data. This beginning was about 1912.

This will include such matters as—

1. The dominant meteorological regimes of these years;
2. The strength and position of the California Current;
3. The intensity of the countercurrent and its period of operation;
4. Temperature regime;
5. Upwelling and nutrient advection;
6. Nature of the plankton;
7. General meteorological; and
8. Oceanographic conditions of the North Pacific.

The data becomes more diffuse as the beginnings of this period are approached, but adequate comparisons with the present research period undoubtedly are possible.

B. Long-term record

The long-term record of the California Current system must be derived from more primitive data—continuous temperature—rainfall and wind data extend from about 1865. It is the purpose of this research to extend our present understanding back through this period and to understand the representivity of the two recent periods in the long-term record. Some earlier accounts of weather, fishes, etc., will be examined to gain additional perspective.

Scripps Institution of Oceanography annual cost------------------------ $60, 000

1.2.2.4 Organic energy budget of the California Current system.—An essential to the thorough understanding of the living resources of a region is the understanding of the food supply to these resources.

For example, in the California Current system the principal food supply may be either the food produced in the current by phytoplankton or the more highly organized food brought by currents into the system. It is now not clear which is dominant, although the important ascribable to such processes as upwelling depend vitally on the understanding of this dominance.

It is first necessary to understand the food supply represented by the zooplankton. This will be done by chemical analysis, covering in a somewhat different way an independent evaluation of the research proposed under paragraph 1.2.2.2.

Secondly, it is necessary to ascertain the level of primary productivity in the system by C^{14} measurements.

Thirdly, it is necessary to determine the relationship between the more highly organized food represented by the advection (of zooplankton, principally), and this local primary productivity. The factor of equivalence probably lies between 10 and 2, which estimate is adequate for the prior work.

Scripps Institutions of Oceanography (3 years) annual cost---------- $25, 000

1.2.2.5. Coastal dynamics of the California Current system—the physics, chemistry, ecology, and structure of upwelling and the countercurrent (including the impact on contiguous area).—Upwelling is one of the important physical variables with respect to fisheries. Despite its importance it is poorly understood, particularly with reference to its causes, its relation to topography, and its ultimate effect on higher trophic levels such as fishes. Thus even though a careful analysis of past data might provide estimates of variation in upwelling, they will furnish no indication of how these variations might affect, for example, the sardine, the anchovy, or the salmons. Though it is important, all over the world, the California Current system offers the best opportunity for definitive study from the point of logistics, background information, and importance.

What is needed is a comprehensive theory, tested with field measurements. A number of recording stations must be moored in the upwelling region to ascertain—

A. The location of the primary upwelling in the upwelling areas. (Some evidence points to primary upwelling over the axis of canyons.)

B. Chemical, radiochemical, and biological indications of upwelling.

C. An evaluation of the effect of upwelling on production and on the distribution and abundance of animals generally.

D. A workable theory of upwelling.

E. A comparative history of upwelling in the California Current system.

Inseparably tied in with a study of upwelling must be a study of the countercurrent. Both undoubtedly are different manifestations of the same general dynamics.

The principal mechanism by which the waters of the California Current system are reinoculated with the southern organisms must be the countercurrent. In addition, the transport of the southerly spawned pelagic fish larvae to the northern part of their range must be by this mechanism. There are many mysteries about this current.

What is needed is—

A. Measurements and a dynamic description of its onset structure and dissolution;

B. An extension of theory to permit analysis of past data;

C. A study of the comparative strengths of the countercurrent in the past; and

D. Effects on organisms.

These two near-shore studies must be integrated, as they must develop their description and theory from interrelated phenomena.

Budget:

Personnel	$100,000
Supplies and equipment	30,000
Vessel time	100,000
Scripps Institution of Oceanography (5 years) total annual cost	230,000

1.2.2.6. Bioassay of organic micronutrients in the sea.—This proposal is directed toward improving existing bioassay techniques, adapting the methodology to cruises, and applying the techniques as a survey and research tool.

Scripps Institution of Oceanography (2 years) cost per year	$15,000
Total cost	30,000

1.2.2.7. Relations between populations of marine organisms and the environment.—This includes research support for five graduate students and one faculty member in marine ecology, and is a continuing program. As an example, one of the studies underway is a study of phytoplankton distribution and abundance, and its relation to physical and chemical properties in the ocean.

Scripps Institution of Oceanography (continuing) annual cost______ $10,000

1.2.2.8. Taxonomic and ecological study of northeastern Pacific tripylean radiolaria.—This is a study aimed at clarifying the classification of these organisms, and elucidating their ecology. It is felt that the results will be particularly useful in a broader respect as preliminary studies suggest these radiolarians will be valuable water mass indicators.

Scripps Institution of Oceanography (2 years) annual cost___________ $14,000

1.2.2.9. Transparency of the California Current system.—This is directed to ascertaining geographical and temporal variations in transparency and the causes of this variation. This parameter is important as an ecological variable and is very pertinent to marine harvest of the resources.

Scripps Institution of Oceanography (3 years) annual cost---------- $15,000

1.2.2.10. Support for general zoogeographical studies.—This is general increased support for a number of SIO staff, faculty, and students engaged in zoogeographical studies in the eastern Pacific.

Scripps Institution of Oceanography (continuing) annual cost-------- $45,000

2.0.0.0. Research on the sardine.—Under this heading are considered research projects more specifically directed to understanding the sardine and other fishes at its trophic level. The organization follows section 1.2.0.0. in that existing projects are listed first followed by new proposals.

2.0.1.0. Existing sardine research.—That is, research adequately or nearly adequately funded.

2.0.1.1. Annual investigation of fishery.—This project includes catch data, sampling sardines, anchovies, aerial surveys, scale reading, etc. (in part with project 2.0.1.6.).

California Fish and Game annual cost------------------------------ $40,000

2.0.1.2. Research on dynamics of sardine population.—(See also project 2.0.1.5.)

California Fish and Game (continuing) annual cost----------------- $8,000

2.0.1.3. Behavior of sardines at sea.—Includes experimental studies designed to improve collecting techniques as well as provide better basic information on behavior. (See also projects 2.0.1.7. and 2.0.1.9.).

California Fish and Game:

Vessel	$20,000
Personnel	6,000
(Continuing) annual cost	26,000

2.0.1.4. Subpopulations of the sardine.—This includes collection and analysis of sardines in order to learn the structure of the population. It involves morphometrics, growth pattern analysis, etc. The final objective is to specify the portions of the population that contribute to the fishery (also, see project 2.0.1.8.).

California Fish and Game (continuing) annual cost------------------- $20,000

2.0.1.5. Population size and population dynamics.—Includes estimating population size by egg and larva data, fishery data, growth characteristics and environmental data. Essentially this is an analysis of the data collected by project 1.1.0.0.

Bureau of Commercial Fisheries (continuing)------------------------ $48,000

2.0.1.6. Age and growth of sardines and anchovies.—In cooperation with project 2.0.1.2. this involves the routine collection, analysis, and publication of the age composition of the catch.

Bureau of Commercial Fisheries (continuing) annual cost------------ $16,500

2.0.1.7. Availability and behavior.—The project is directed toward understanding the availability of sardines as a function of behavioral responses to the environment. It involves field and laboratory investigations. (See also projects 2.0.1.4. and 2.0.1.9.).

Bureau of Commercial Fisheries (continuing) annual cost------------ $46,800

2.0.1.8. Genetic analysis of the sardine population.—This project is directed toward analysis of blood types, believed to be inherited, in the sardine population. It should supply phenotypic free assessment of the population. It is closely coordinated with 2.0.1.4. above.

Bureau of Commercial Fisheries (continuing) annual cost------------ $7,000

2.0.1.9. Physiology of sardines.—This is a relatively new project. Its aim is to explore and understand the physiology of the eggs, larvae, and adult sardines in order that the effect of environmental parameters can be meaningfully specified.

Bureau of Commercial Fisheries (continuing) annual cost $21,000

2.0.1.10. Laboratory studies of behavior.—Studies of the response of sardines and anchovies to temperature, light, and other environmental gradients.

California Academy of Science (continuing) annual cost $7,500

2.0.2.0. New Research Proposed on Sardine.

2.0.2.1. Reduction, analysis, and publication of pelagie fisheries back data.—This subproject will consist of the salary and expenses of a marine biologist together with clerical and other machine help. It is one of the applications of the capitol project 4.0.0.3. which involves establishment of a computer center.

California Fish and Game (3 years) annual cost $25,000

2.0.2.2 Relation of larval survival to the environment.—Following leads developed by SIO and the BCF, it is proposed to conduct an exhaustive study of all past data on larval distribution, abundance, and sizes, and all environmental data.

Senior scientists are available. Needed is a junior biologist with mathematical training, two technicians and funds for machine analysis.

Scripps Institution of Oceanography-Bureau of Commercial Fisheries (3 years) annual cost $30,000

2.0.2.3 Comparative study of food of sardines, anchovies, jack mackerel, Pacific mackerel, especially when they occur in the same areas, etc.—This study is needed to understand the interrelationships of these species, and to determine the extent of their competition for food. This will contribute to a better understanding of shifts in the relative abundance of these "competing species."

Data will be collected on commercial vessels and existing research cruises so funding is needed only for a biologist and one assistant.

California Fish and Game (3 years) annual cost $13,000

2.0.2.4 Survey of catch statistics of the California wet fish fishery.—The objective is to provide the most meaningful basis possible for evaluating routine catch statistics in terms of population parameters. This project is timely because there have been so many economic, biological, and technical changes in the fishery that a thoroughgoing field study of the fleet is needed to provide a modern analytical description of its operations.

Required is a scientific leader, one clerk, possibly up to one-half time of a consulting economist, and machine processing time for 3 years.

California Fish and Game (3 years) annual cost $22,000

2.0.2.5 Restudy of age and growth determination.—A thorough study of the methodology of age and growth by a senior scientist, possibly on a contract basis is envisioned. Such a study is desired because new and intensive utilization of the age and growth data require greater precision and evaluation of error than was required when the present system was established.

California Fish and Game or Bureau of Commercial Fisheries (2 years) $114,000

2.0.2.6 Rearing pelagic marine fisheries.—This is an attempt to develop the methodology of rearing marine pelagic fishes—a field that has been hardly touched. Of necessity a great deal will be learned about the life requirements of the fish, as well as setting the stage for the next step which will be the experimental study of the effects of varying environmental parameters on the animals.

Four senior scientists (a physiologist, a microbiologist, a biochemist, and a reviewer) plus their physical, and human support.

Bureau of Commercial Fisheries:

4 years, annual cost	$65,000
1st year equipment	100,000
Total 1st year cost	165,000

2.0.2.7 Estimate from available data the probable population size, stability, and distribution of the ecologically important pelagic fishes including hake, jack mackerel, anchovy, saury, squid, and elasmobranchs.—This should be carried out by biologists associated with the Bureau of Commercial Fisheries, La Jolla Laboratory, and the California Fish and Game, Terminal Island Laboratory. These biologists should examine fecundity, egg larvae data, and the juvenile and adult fish data, and the literature to obtain these estimates. Some travel and assistance will probaby be needed.

California Fish and Game-Bureau of Commercial Fisheries (2 years) annual cost	$25, 000

2.0.2.8 Elucidate the probable interrelation of these ecologically important pelagic species with preferred sport and commercial species.—The same biologists as under project 2.0.2.7 should examine this problem from existing data on food, considering larval, juvenile, and adult relationships.

California Fish and Game-Bureau of Commercial Fisheries (2 years) annual cost	$10, 000

3.0.0.0 Capital expenditures

These are capital expenditures not closely related to any particular project.

3.0.0.1 Oceanographic research vessel.—It will become increasingly difficult for marine life research to obtain one of the larger Scripps vessels for long periods of time. This is due to increased activities in oceanographic research in the ocean far from California. The Navy and the National Science Foundation are rapidly increasing their funds for ocean research into such areas as the Indian and Arctic Oceans. Thus a special CALCOFI research vessel may become necessary for full realization of the research.

The ship would be used for many types of research as listed below:

1. Monitoring oceanographic conditions;
2. Anchoring and maintaining instrument skiffs;
3. Midwater trawling;
4. Launching and recovering deep free instruments;
5. Testing new net designs and other equipment;
6. Spawning studies;
7. Schooling studies;
8. Physical and biological boundary conditions; and
9. Direct surface and subsurface current measurements.

A ship for CALCOFI research can probably be obtained through educational surplus for a fee of approximately $500. The largest expense would be for conversion to Coast Guard specifications and for research use.

It it desirable that the vessel have an adequate laboratory but not extremely large and have bunking space for 12 scientists.

There will have to be a winch large enough to handle midwater trawls, and for the mooring of skiffs, but not as large as necessary for very deep, heavy coring requirements. Also an A-frame will be necessary to handle the equipment that is lifted and operated over the stern.

This ship should be outfitted with excellent navigational aids. It should have the best commercial radar, preferably with an A-scope read-out and two antennas at different heights to make the radar useful at close ranges. Also important equipment is two read-out lorans, a sonar (perhaps British type of mine hunting sonar).

Two underwater observation ports would be valuable for the marine biologist.

Conversion cost	$400, 000

3.0.0.2 Underwater camera.—In the past few years, underwater photography has greatly improved. It has become possible to photograph life in the sea from the near surface to the deepest depth. With photographic records, biologists, geologists, and others can rapidly and with greater ease resolve some of the problems of the oceans.

The CALCOFI program could benefit from the use of a good underwater camera such as developed by Harold T. Edgerton. It could be used to photograph the areas of spawning sardines and other pelagic fish. So far, it has not been consistently possible to collect spawning sardines very far from the coast. At any rate, collecting can scarcely reveal much about the spawning associations of sardines and it may be profitable to obtain underwater photographs in spawning areas in an attempt to ascertain if the fish spawn in a school or as widely separated pairs. This also should reveal the nature of the larger associations of the sardine during spawning. Other areas of study would be photographing the shallow scattering layers. The part of the zooplankton and fish population composing the scattering layer is very little known. It may be composed of food supplies of the small particulate feeders.

Other valuable work with the camera could be its use in conjunction with various nets. We may be able to determine some of the fish that escape our midwater trawl and nekton nets, the size of those that escape, and the distance of net detection. The camera may also be used to try and study schooling fish in relation to its predators. On a number of traces made by the precision depth recorder there are heavy traces of what appear to be schools of fish below that we consider the deepest depth that sardines, anchovies, and herring swim. It would be of great value to know what these traces on the precision depth recorder represent.

Other uses less related to the present CALCOFI program are the bottom fish at all depths of the ocean floor. The relation of types of ocean floor to species, size, and numbers of fish would be of value to fishing in deeper water by commercial fisherman.

The primary cost for some of these programs is the camera and its accessories. The CALCOFI program at Scripps Institution can supply ship time for studies involving the use of a camera. Our marine biologists have shown much interest in using a camera if it were available.

Total cost ---------- $13, 590

3.0.0.3 Computer center—establishment of a scientific data processing unit at the California State Fisheries Laboratory to process and analyze large amounts of fisheries data. This will consist of a computer center including an electronic, desk-size, stored program computer with auxiliary equipment capable of handling IBM punchcards.

California fish and game ---------- $101, 500

3.0.0.4 Fisheries oceanography.—The Department of Fish and Game vessel *N. B. Scofield* has been in commission for 23 years and will need to be replaced soon. There have been several soft spots discovered in the wood of this vessel, all in critical locations such as the stem, stem post, and midship below the main engine. This condition will become worse with time. Therefore there is a need to replace the vessel.

The ship would be used for many types of research as indicated below:

1. Monitoring oceanographic conditions;
2. Bottom and midwater trawling;
3. Long-line and live-bait fishing and trolling;
4. Round haul net fishing;
5. Fishing with gill, trammel, and blanket nets;
6. Fish behavior studies, including schooling and spawning behavior; and
7. Special oceanographic and biological studies.

A vessel for this variety of work would have to be designed and built. It should be from 115 to 120 feet long. Its beam should be from 29 to 30 feet and its depth from main deck to keel about 17 feet.

It should have bait wells with a total capacity of about 2,000 cubic feet and a portable bait tank of 150 cubic feet. There should be a 500 cubic foot capacity walk-in freezer for specimens and two 20 cubic foot portable boxes.

It should be equipped with several winches including one northern dragger winch for trawling and one hydrographic winch.

There should be bunking space for 20 men, mostly below deck; and about 180 square feet of laboratory space on the main deck. The ship should be outfitted with gyro compass, the best commercial radar, loran, and a sonar giving fine definition for locating fish schools.

Two underwater observation ports would also be built in the vessel.

Based on estimates received the total cost for such a vessel complete with all equipment would be approximately $175,000.

4.0.0.0. Research and analysis designed to translate the fund of basic knowledge into information usable to the public (utilization research)

The general objectives of this need are contained in the statement previously brought to the attention of the Marine Research Committee, entitled "Proposed Fisheries Research," which statement the MRC included in the minutes of their meeting of July 30, 1959. This program subsequently has been presented and discussed with several other bodies including the Northern Seafood Institute and the Aquatic Resources Committee. These presentations were made the focal point of a scheduled meeting of each of these groups and were made to obtain their comments and criticism rather than directly for financial support per se. The discussions following these presentations were extended, favorable, lively, and very enthusiastic.

It is now appropriate to introduce some preliminary estimates of the cost of such a program.

The initial steps needed to sensibly design such a program will be met if two consolidating studies under sardine research (projects 2.0.2.7. and 2.0.2.8.) are completed. These two studies as well as satisfying other questions, in effect lay the groundwork for this program.

This program is being advanced as an appendix, as it were, to this report. That is, rather than saying that we, the CALCOFI Committee, or any of our parent agencies are ready to embark in this new direction, we are simply passing on what we believe to be a worthwhile suggestion.

4.0.1.0. Phase 1.—This is the initial task of bringing together all existing data that is pertinent to the problems of utilization. Some new data will, of necessity, be acquired, but long research programs will not be mounted. This phase will serve to answer some questions, but more importantly will lay the groundwork for well directed utilization research. (See projects 2.0.2.7. and 2.0.2.8.)

4.0.1.1. Appraise the availability of ecologically important species to present and eventual fishing potentialities.—This should be attacked by a behaviorist familiar with fishing gear, including locating devices. It should include enough experimental work to permit identification of the major problems, especially where the present data are insufficient to permit an estimate of availability, or there are conflicting opinions or evidence on the availability. Thus, some fish boat charter and gear rental is included in the estimate.

Unspecified (2-years) annual cost	$100,000

4.0.1.2. Investigate the capture and utilization of similar species elsewhere.—Literature, survey, travel, salary.

Unspecified (2 years) annual cost	$50,000

4.0.1.3. Estimate the potential supply in relation to the future demand and market for these species.—Essentially this involves collation of all the results of phase 1, together with economic appraisals and evaluations, reinforced by technological surveys and analyses as needed.

Unspecified (2 years) annual cost	$50,000

4.0.2.0. Phase 2.—This involves research and development needed to clarify and further expand the results of phase 1. Phase 1 asked what we now know about the utilization of the resources. Phase 2 will seek to bring our knowledge to an operationally significant level. Of necessity the cost estimates are very preliminary.

Unspecified (2 years) annual cost	$50,000

4.0.2.1. To quantitatively answer the following questions: What is the probable influence on the preferred stocks of fisheries? How can the restraints on the development of these resources be overcome? What are their probable size and value?—This will involve a spectrum of research ranging from special biological studies, through gear development, technology, and marketing. There should also be considered more general effects on the economy such as the effect on the poultry industry.

Unspecified (5 years) annual cost	$200,000

APPENDIX 3—CHAPMAN STATEMENT

CALIFORNIA FISH CANNERS ASSOCIATION, INC,
Terminal Island, Calif., January 31, 1961.

HON. HENRY LABOUISSE,
Administrator, International Cooperation Administration,
Washington, D.C.

MY DEAR MR. LABOUISSE: We are not certain whether the following material should be addressed to you, to the Secretary of State, to the Secretary of the Interior, or perhaps elsewhere in the U.S. Government, because it deals with topics cutting across lines of responsibilities and interests. Accordingly, we have addressed copies of it to other officers in the Government as noted in the terminal paragraph.

Nigeria at present uses about 260,000 to 320,000 tons of fish per year, expressed in short tons of fresh fish equivalents. Expressed in the same equivalents about 160,000 tons of this amount (valued at U.S. $25 million) are imported from countries around the North Atlantic (chiefly Norway and Iceland) in the form of dried stockfish. About another 50,000 tons in the same equivalents (and also in dried form) are imported from the Chad-Chari fisheries of the nearby Republic of Chad and the fisheries of the Upper Niger as far away as the Republic of Mali. About 50,000 tons of the remainder is produced internally in Nigeria. All but 3,700 tons of this is produced by canoe fisheries of the most primitive sorts operating in the rivers, creeks, lagoons and very nearby sea (in calm weather.) It is processed, transported and marketed by the most primitive and unhygienic means. The 3,700 tons of fish (which out of the whole lot of perhaps 300,000 tons a year is all that would meet American or most dietary standards) is produced by 11 tiny trawlers and mostly consumed fresh in Lagos, the capital city.

Quite aside from the expenditure of foreign exchange which the above brings about, the product is almost all of very low standard when it reaches the consumer not at all cheap by any standards, and is far from sufficient for the dietary needs of the upwards of 35 million Nigerian people.

Protein deficiency is common in the diets of the peoples of the rain forest and nearby wooded savannah areas of both western and eastern regions (as well as the southern Cameroons). It is particularly acute among the very young and in the form of Kwashiorkor is a major contributor to the abnormally high infant mortality rates in these areas of Nigeria as well as similar areas of other countries in tropical West and Central Africa. The poorer classes of the urban and peri-urban areas not only of these regions but of the federal territory and northern region of Nigeria suffer from chronic protein deficiency which does not produce the striking effects of Kwashiorkor but is nevertheless important in contributing to the general physical debility of these peoples and their lowered resistance to the many other diseases endemic in tropical Africa.

In view of the difficulty of raising livestock in the area infested by the tsetse fly major dependence for protein in the diet must be placed upon fish both now and in the immediate future. This suits the dietary desires of the people.

If 300,000 short tons of fresh fish equivalent weight be taken as the present annual consumption of fish in Nigeria a total need of 350,000 tons per year would not appear to be unreasonable. With population increasing at the rate it now is, and has been for some years, an estimate of 400,000 tons in these equivalents as the Nigerian need for 1970 is certainly conservative.

While it is highly doubtful that the inland waters of Nigeria could produce on a sustainable basis anything like the volume of fish which Nigeria requires, it is just as certain that the high seas adjacent to the country could easily produce all of this fish on a sustainable basis and leave over a comfortable margin of readily salable products which would earn foreign exchange.

The primitive fishing industry of Nigeria is quite incompetent ever to meet these needs by its own initiative. The Government of Nigeria has asked the Special Fund of the United Nations and the Expanded Technical Assistance Program of the Food and Agriculture Organization for specific fishery aid projects. These projects are good enough in themselves but fall far short of being able to meet Nigeria's fishery needs in any reasonable length of time.

The Federal Fishery Service, with the agreement of the Ministry of Economic Development, does have a project which would lead to the tapping of these great offshore fishery resources by Nigeria in a reasonable length of time. This is called the Tin-Can Island scheme, and very closely resembles the fish harbor project engaged in by the Government of Pakistan at Karachi with the aid of the International Cooperation Administration.

Neither foreign enterprise nor domestic enterprise can be attracted to the rapid development of Nigeria's fisheries in the present congested condition of Lagos Harbor, and there is presently no other harbor in Nigeria where modern vessels can be practically accommodated, or where their product can be readily transported into the interior where it is needed. Port Harcourt is 40 miles from the sea and does not have good interior lines of communications. The Escranos River entrance will not be fully navigable for 2 or 3 years yet and its interior lines of communications are as yet nominal.

Tin-Can Island comprises about 100 acres of mangrove land, very little of which is more than a foot above high tide level and a good deal of which is below that level. It lies directly west of the industrial area of Apapa from which it is separated by a narrow creek. Its southern boundary faces on the international waterway leading from Lagos Harbor to Dahomey.

This waterway is deep enough without further dredging to accommodate high seas fishing vessels of the size and draft apt to be used in the area. Dredging operations directly in front of the island would produce enough fill to make this island into a flat land suitable for industrial development. The creek to Apapa could be conveniently bridged by a Bailey-type bridge, with which there has been considerable satisfactory experience in Nigeria. Water and power could be brought to the island from nearby Apapa by the same means.

The scheme envisions the fill of 20 acres of the island as a start, the construction of wharves and sheds for the accommodation of fishing vessels and their catches, adequate flat land upon which to construct processing plants, boat repair yards, and other facilities needed by a modern fishing and fish processing industry.

The Federal Fishery Service calculates that bridge, fill, dredging, wharves and basic facilities will cost £500,000 or about US$1,400,000. We calculated that the total bill would come closer to US$3 million if ICA undertook it because ICA would wish to do things in a little more complete and permanent fashion if it undertook the job, and if it were to maintain the high and excellent standards we saw at the modern fish harbor development at Karachi.

During the course of a recent trip to Nigeria, one of us inspected this site and talked about it with Mr. Johnson, Director, Nigerian Federal Fishery Service, and Mr. Lewis, Federal Ministry of Economic Development. It was also discussed with Mr. Olnick of the local ICA staff in Nigeria. Mr. Lewis and Mr. Johnson were told that it appeared to be a practical scheme from the fishery standpoint and it was suggested that the Government of Nigeria make a formal request to ICA in respect of it. Mr. Olnick was informed as to what had been done, and was told that we were intending to bring the subject to the attention of the appropriate authorities in Washington, D.C., which we hope we are doing with this letter.

Additionally, one of us talked with Mr. F. Clark, director, West African Cold Storage Co, in Lagos (an affiliate of Unilever). Mr. Clark said that he was acquainted with the Tin-Can Island scheme and that his company was prepared to build a 4,000-ton refrigerator plant in the Lagos area for handling fishery products if they could locate the land to build it upon and if other basic facilities were made available so that a modern fishing industry could grow in that area. Two of our major California fishing industries have already inspected the area; the representatives of two of our firms will be in Lagos looking into it before this letter reaches you, or very shortly thereafter.

We recommend that ICA look into this matter in Lagos and, if the situation is as it was represented to us, give the Government of Nigeria such technical assistance as is wanted and appropriate for drawing up of a proper request for the project. We agree with Messrs. Lewis and Johnson that some such project which will provide the basic facilities of land, wharves, repair yards, etc., are necessary if the sea fisheries of Nigeria are to develop in accordance with Nigeria's needs.

We believe it to be desirable from the viewpoint of U.S. policy and interest that this be viewed with considerable urgency for reasons noted below.

Two other fishery projects not concerned with Nigeria alone, but with the whole of west Africa as well as Nigeria, deserve to be mentioned too. One of them is perhaps appropriate for ICA to consider in view of its recent fishery oceanography project in the vicinity of Thailand; the other is certainly appropriate for consideration by the appropriate officers of the Department of State and the Department of the Interior, and should be considered as part of any well-rounded scheme for the development of the fisheries of west Africa.

At a meeting of sea fishery and oceanography specialists held under the auspices of CSA in Monrovia, Liberia, on and after December 3, 1960, a scheme was proposed which envisioned a general survey of the oceanography and the sea resources of west Africa. A resolution was adopted suggesting that the Commission for Technical Cooperation in Africa South of the Sahara (CCTA/CSA) ask its member governments to seek on an urgent basis external scientific, technical, and financial aid in undertaking this project which would be expected to yield basic assistance to 60-odd million people living in the 10 or so countries bathed by the Benguela Current, the Canary Current and the Counter Equatorial Current.

It is known that the oceanographic conditions of the eastern tropical and subtropical Atlantic are similar enough to those of the eastern Pacific that the biological productivity of the area must be large. Working on the basis of this knowledge the fishing industries of these Asian, North American, and European countries have been developing the high seas fisheries off west Africa during the past 5 years and with increasing tempo the last 2 years.

The known oceanographic and fishing information of the area has not been available to these new African nations in a form useful to them for the reason that they do not have scientific establishments competent to translate these data into practically usable terms nor do they have the fishing industries yet that are sophisticated enough to make use of the information if it were translated into usable terms.

The nucleus fishery staffs that these new countries do have realize, however, the imperative need of gaining this information quickly so that their fish requirements can be met by building their own fishing industries based on these data and these resources. They think this so strongly that they wish to go forward with this survey on an urgent basis seeking help for it either from East or West or both. There are obvious international political and defense benefits to the United States which would derive from this work being done under the leadership of American scientists.

A third scheme appeared from the Symposium on Tunas conducted under the auspices of CCTA/CSA at Dakar, Senegal, December 17 to 21, 1960. This symposium recommended to CCTA/CSA that that international organ recommend to its member countries the calling of a conference of plenipotentiaries for the purpose of concluding a treaty establishing an International Commission on Tuna for the tropical and subtropical Atlantic along the lines of the Inter-American Tropical Tuna Commission that operates in the eastern Pacific and for the same purposes.

The symposium considered that such an international conservation commission was mandatory in respect of tuna because already the fishermen of four continents were fishing on these stocks of tuna, nobody was keeping the required basic statistics to learn when or whether conservation measures would be required, and that the African nations were quite unable to handle this international problem alone.

This is the sort of thing at which the Department of State is expert. The United States is presently a member of nine of these international fishery conservation commissions which are working well. The United States has repeatedly taken the lead in establishing such commissions and calling conferences for this purpose even where (as in whaling) the United States has less direct interest in the fishery than it has in the west African tuna fishery. The Department of State has skilled experts in this sort of thing and the Department of the Interior has skilled experts in the scientific managerial aspects of such problems.

We believe that it would be desirable for the U.S. Government to look into this matter, take such actions as appears to be appropriate, and proceed on it with considerable urgency because the tuna fisheries of west Africa are growing with surprising rapidity both as to production volume and as to the number of nations participating in them.

There is a fourth subject that needs to be looked at with respect to Nigeria in particular and probably also in neighboring countries. That is the provision of credit facilities.

If the Tin-Can Island scheme is put in train there will be the possibility of a domestic Nigerian sea-fishing industry growing, which is the desideratum. There is not inconsequential moneys available in Nigeria, both private and governmental which could be attracted to these purposes but it is doubtful if there is enough to meet the requirements of motors for canoes, nylon webbing for nets, small trawlers, processing equipment, and latterly larger modern seagoing vessels. To nurture the use of Nigerian capital in these enterprises there will be required, we believe, sums of capital for loans mostly on a rather small scale and with liberal terms of repayment. This is probably as important to the overall purpose of building a Nigerian fishing industry as are the basic facilities of such a scheme as the Tin-Can Island one. It is certainly an appropriate subject for the proper U.S. agency to look into.

We have dwelt at considerable length on Nigerian fishery developments for these reasons:

1. Nigeria's large human population desires and needs fish.
2. Nigeria is rather ideally situated in respect of the abundant high seas fishery resources of the west Africa area.
3. The Governments of Nigeria and of its several regions are actively interested in developing their fisheries.
4. Nigeria has a large fishing population having long fishing traditions. These have had all or most of their experiences in the fresh water fisheries of west Africa but appear to be readily adaptable to being developed into sea fisheries.
5. The business community of Lagos and Western Region seem fully prepared to go forward in such developments if basic facilities can be provided, and
6. The present political complexion and stable progressive nature of the Nigerian Government is such as will attract in American fishing firms with their technical know-how and even capital. We believe that a considerable amount of such sophisticated capability will be required to prime the pump of bringing Nigeria's presently very primitive fishing industry up to modest but modern capabilities in high-seas fisheries.

We believe that all of this is highly desirable from the standpoint of overall objectives of U.S. diplomacy and defense. Our private sources of trade information indicate that Russia has quickly seen the political significance of great unused fish resources immediately adjacent to large human populations badly in need of animal protein in their diet. Accordingly Russia is in the process of offering Ghana all of the facilities noted above and some additional ones. Poland is purported to have made similar offers to Guinea. We learn from competent sources that Russia has under study the making of the broad oceanographic and fishing survey off west Africa recommended by the Monrovia symposium noted above.

Obviously it would be advantageous for the U.S. Navy rather than the Russian Navy to have the advantage of a thorough knowledge of the west African seas. It would be even more desirable for the United States to demonstrate in west Africa what its peculiarly competent combination of private and public enterprise can accomplish in such a situation, while materially aiding these peoples both economically and nutritionally.

From our background of experience we believe that Nigeria has the possibilities of being made into a show case of fishery development and that American industry can contribute materially to this objective there.

In view of the fact that what we have set forth here is of wider scope than the responsibilities of your office we are taking the liberty of sending copies of this letter to Mr. Rusk, Secretary of State, Mr. Udall, Secretary of the Interior, Mr. Dillon, Secretary of the Treasury, and Admiral Burke, Chief of Naval Operations.

Sincerely yours,

Chas. R. Carry,
Executive Director.
W. M. Chapman,
Director, the Resources Committee.

APPENDIX 4—CHAPMAN STATEMENT

CALIFORNIA FISH CANNERS ASSOCIATION, INC.,
Terminal Island, Calif., January 31, 1961.

HON. G. MENNEN WILLIAMS,
Assistant Secretary for African Affairs,
Department of State, Washington, D.C.

MY DEAR MR. WILLIAMS: This letter is concerned with the part played by fisheries in the nutrition and health of the peoples of tropical Africa, particularly west Africa, the moves being made presently by Russia and her satellites to capitalize on this situation to the international political benefit of the Communist world, and what moves the United States might make in this field which would enhance the economic and nutritional position of these several peoples and by so doing contribute to political stability in the area.

In the belt of jungle and nearby wooded savannah that stretches across most of central tropical Africa various diseases transmitted by the tsetse fly render the raising of livestock largely impractical. This is also the belt of tropical Africa in which the human population is most dense. The upshot of these two factors is that human population in the area is substantially dependent upon fish (mostly dried and smoked because of both the general poverty of the consumers and of the hot, humid climate of the area) for the animal protein part of their diet. Although substantial quantities of dried fish is imported from the Northern Hemisphere and elsewhere, protein deficiency is a serious problem throughout the area and with most age classes, and in younger children is responsible in large measure for the abnormally high mortality rates resulting from the deficiency disease known as Kwashiorkor.

It is one of the incongruities of nature that the high seas off west Africa, and adjacent to this belt of jungle and wooded savannah, is one of the most productive of the ocean areas of the world in precisely the sorts of fish relished by the people ashore who need them. These are the pelagic fishes—the herring-like fishes of the genus Sardinella and Ethmalosa, and the tunas (yellowfin and skipjack primarily).

The pelagic fishes of the high seas are almost as unavailable to the shoreside fishermen of these coasts as if they were on the moon because of the primitive nature of the coastal fishermen, their gear, vessels, and means of preserving and marketing their catches. They are unable to go to sea to follow the fish; they must await the poorly understood vagaries of the ocean currents bringing the fish in to the beach within reach of their canoes.

An example in point is provided by Nigeria. A recent estimate by the United Nations is that the inhabitants of Nigeria (somewhat over 35 million strong) eat at present the equivalent in fresh fish of about 260,000 to 320,000 tons of fish per year and are still—as are all other inhabitants of the area—short of animal protein in their diet and subject to the physical debilities that arise therefrom.

Of this present use of fish the equivalent of about 160,000 tons fresh weight (but in the dried form) is imported from the Northern Hemisphere at a cost of about US$25 million per year (which is a drain upon foreign exchange). Perhaps another 50,000 tons in fresh weight equivalents is imported (again in the dried form) from the fisheries of Lade Chad and the Chari River in the nearby Republic of Chad, and from the upper Niger as far away as the Republic of Mali. The remaining 50,000-odd tons of fish used currently in Nigeria is produced by her own fishermen from internal waters.

Of this 50,000 tons of domestically produced fish most is produced by canoe fisheries of the most primitive nature, dried and smoked in the most primitive manner, and mostly walked to market through jungle roads and paths in the most primitive manner, where it is marketed under horribly unhygienic conditions after being subject to high spoilage brought about by the hot, humid climate and major depredations by the omnipresent beetle larvae. It is estimated, for instance, that of the product of the Chad-Chari fishery which is dried and shipped to southern Nigeria only between 15 and 25 percent of the original weight reaches the consumer in a condition fit for human consumption.

Of all the sources of fish in the Nigerian diet only 3,700-odd tons (or about 1½ percent) are produced by modern vessels from the sea under modern conditions of preservation and hygiene. These are landed by 11 small trawlers operating out of Lagos without benefit of modern port facilities.

Yet the high seas directly adjacent to Nigeria are full of sardine, shrimp, lobster, tuna, and a variety of sea fishes sufficient not only to satisfy fully the needed protein component of the Nigerian diet but also to provide a surplus of eminently salable products.

While the situation of Nigeria has been discussed in some detail the description reasonably well sets forth the conditions in Angola, the Congo, the French Cameroons, Togo, Dahomey, Ghana, the Ivory Coast, Liberia, Guinea, Sierra Leone, Gambia, Senegal, and Mauretania as well.

The fisheries of the high seas off west Africa have begun to be harvested in the past 5 years by fishermen of the United States, Russia, Poland, France, Japan, Norway, Nationalist China, Portugal, Spain, Italy, and Greece. While most of these have begun with tuna, the trawl fisheries are being developed on a considerable scale.

The Russians (being state-owned and not under the necessity of showing a profit) have gone ahead at a more rapid rate than have the independent American vessels and companies. In particular, they have developed an important trawl fishery for sardine off Ghana and the nearby area. They have expanded this fishery rapidly and have had (with satellites Poland and East Germany) at least 17 large trawlers and motherships working the west African area during the last half of 1960.

Having discovered not only the abundance of fish offshore but the need for fish among the inhabitants of these countries, the Russians are now moving in rapidly to take political gain from putting these two factors together. Whereas the Russians originally intended to use the fish catches solely for home consumption, they quickly realized the benefits to be gained from allowing important quantities to be marketed locally. Additionally, our private commercial lines of intelligence inform us that within the last 6 months Poland in Guinea and Russia in Ghana have agreed to equip these respective countries with modern fishing industries, vessels, gear, processing plants, repair yards for fishing vessels, marketing studies, technical aids, and training for their people in fisheries and fisheries science.

Two of our companies (Star-Kist Foods, Inc., in Ghana, and Van Camp Sea Food Co., Inc., in Sierra Leone) have made modest beginnings in the area, are prepared to do more, and other companies have become similarly interested. These privately owned corporations and entities are unable, however, to compete in any successful degree with the fishery largess now being offered by Communist governments in the area.

We believe that the United States through the International Cooperation Administration and otherwise is fully competent to move in on worthwhile fishery projects desired by such governments as Nigeria, for instance, and by such international agencies as the Commission for Technical Cooperation in Africa South of the Sahara (CCTA/CSA), which cauld provide these peoples with the aids they need to help themselves modernze and make efficient their fish productive industries without political ties to Communist countries.

Our people are experienced and knowledgeable in the area and in fish production, processing, and marketing. We do not like to see Communist political advantage being gained in fields in which Americans are particularly proficient and competent to do the job.

We and our members would like to be able to help you and the U.S. Government in this matter in any appropriate manner. Attached hereto is a copy of a letter to Mr. Labouisse, International Cooperation Administration, that sets forth in more detail this problem and suggests four more or less specific projects of the sort which we believe the Department of State, Department of the Interior, and the International Cooperation Administration could usefully undertake in the area, and in some of which the U.S. Navy may have more than a casual interest.

Sincerely yours,

CHAS. R. CARRY,
Executive Director.
W. M. CHAPMAN,
Director, the Resources Committee.

The CHAIRMAN. We will recess until 9:30 tomorrow morning.

(Whereupon, at 12:20 p.m. the committee adjourned, to reconvene at 9:30 a.m., Thursday, March 16, 1961.)

MARINE SCIENCE

THURSDAY, MARCH 16, 1961

U.S. SENATE,
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
Washington, D.C.

The committee met, pursuant to adjournment, at 9:45 a.m., in room 5110, New Senate Office Building, Hon. Warren G. Magnuson (chairman of the committee) presiding.

The CHAIRMAN. The committee will come to order.

We have a long list of witnesses here.

We are honored today to have with us the Secretary of the Navy, who wants to make a brief statement about the whole field of oceanography as it pertains to much of the important work of the Defense Department, and particularly the Navy.

Mr. Connally, we will be glad to hear from you briefly on this matter. I know that you don't have a prepared statement. But I know that you are cognizant of the general objectives of this legislation, which of course passed the Senate last year, and the importance in a general way of oceanography to the work of the Navy and the mission of the Navy; let's put it that way.

STATEMENT OF HON. JOHN B. CONNALLY, SECRETARY OF THE NAVY

Mr. CONNALLY. Mr. Chairman, Senator Schoeppel, it is a great privilege for me to be here this morning and I am grateful for the opportunity to do so. I am not going to present any specific testimony with respect to the bill now before the committee, because I think we are extremely fortunate in the Navy in having Dr. James H. Wakelin, who is Assistant Secretary of the Navy for Research and Development, who will appear before this committee at a later time and give the official Navy views with respect to this particular legislation. I might say in that connection that we are particularly proud that the Navy has been honored by having the chairman of the Interagency Committee on Oceanography, and the chairman is Dr. Wakelin. I feel that he will be a very competent witness to appear before the committee.

It is extremely heartening to us to know the interest that this committee has in this basic problem of oceanography. Obviously the Navy Department is not the only entity in the Government that is interested in this work. There are many, many agencies of the Government that are vitally concerned with it. There are many contributions being made to the overall matter by Government as well as private agencies.

All I want to say to you is that particularly in the light of the missions and the capabilities which the Navy now has, there has never been a time in our history when this particular field has been more vital to us.

We are interested in making as much progress as we can, as rapidly as we can.

Again to this committee, in behalf of all the Navy, I want to express our deep gratitude for the attention which is being paid to it.

The CHAIRMAN. Thank you, Mr. Secretary. We appreciate your coming up. We will look forward to the doctor coming and giving us some of his views on modifications or technicalities in the bill. I know the Navy has long supported the general objectives of the bill.

Mr. CONNALLY. Thank you very much.

The CHAIRMAN. I wonder if Dr. Fernald could testify first, because he has to leave at noon, as I understand it. Will you come forward, Doctor.

Dr. Fernald is the director of Friday Harbor Laboratories, University of Washington, at Friday Harbor, which is a marine station of the University of Washington. We are glad to hear from you, Doctor.

STATEMENT OF DR. R. L. FERNALD, DIRECTOR, FRIDAY HARBOR LABORATORIES, UNIVERSITY OF WASHINGTON, FRIDAY HARBOR, WASH.

Dr. FERNALD. My name is Robert L. Fernald. I am an associate professor of zoology at the University of Washington and director of its marine station, the Friday Harbor Laboratories. I am pleased to have the opportunity to speak personally in support of the Marine Sciences and Research Act of 1961, which seeks to establish at the national level an expanded and comprehensive 10-year program in study and research in the marine sciences. The stimulus and the encouragement which such a measure would give to this neglected area of science is sorely needed.

At the University of Washington advantage has been taken of our geography and natural resources, and study and research in the marine sciences in the broadest sense have been encouraged to develop in a number of different organizational areas.

I might say that these include a number of organized departments at the Seattle campus, college of fisheries, the applied physics laboratory, institution of radiation biology, fisheries research institute, and others.

In addition one such area is represented by the Friday Harbor Laboratories, located on San Juan Island in marine waters between Vancouver Island and the mainland, which have been active for the past 57 years—except for a period during World War II—as a marine station of the university. These laboratories are administered as an independent unit under the dean of the graduate school with the cooperation of a number of interested departments and colleges, namely, anatomy, botany, fisheries, meteorology, microbiology, oceanography, and zoology. I am happy to use the laboratories as an illustration of the role such smaller stations have and can play in the development of marine sciences.

The CHAIRMAN. Doctor, I suppose there is a good reason for it, but wouldn't there be some reason for the school of medicine to have a direct interest in this matter?

Dr. FERNALD. They are actually represented here.

The CHAIRMAN. In zoology?

Dr. FERNALD. As a specific department, the department of anatomy, and I should have mentioned biochemistry, and microbiology, also a division of the medical school.

I am happy to use the laboratories as an illustration of the role such smaller stations have and can play in the development of marine sciences.

The original laboratory, known as the Puget Sound Marine Biological Station, was established as a permanent installation in 1904 through the efforts of two professors of biology, Dr. T. C. Frye, botany, and Prof. Trevor Kincaid, zoology.

The CHAIRMAN. You can see, Doctor, how old the chairman is getting. Professor Kincaid was one of my teachers at the university.

Dr. FERNALD. Instruction in marine biology was offered and summer research activities centered in the main around taxonomic and field studies of local marine fauna and flora. Students and investigators came from various parts of this country and abroad, and many notable contributions to the knowledge of marine forms were made and published in the serial publications of the Puget Sound Marine Biological Station. The laboratories were relocated in 1922 on a 484-acre site ceded to the university by the Federal Government. As interest in physical and chemical oceanography developed at the university, the station was for a time organized as a part of the division of oceanography. Instruction and research were extended into the areas of physical and chemical oceanography, fisheries, biology, microbiology, and meteorology. Thus a number of scientific disciplines with interest in problems related to the marine environment have continuing activities at this laboratory. In the informal atmosphere of a small marine laboratory there is a real value in the association and exchange of ideas between graduate students and advanced investigators interested in different aspects of marine sciences.

The Friday Harbor Laboratories was one of the first university affiliated marine stations to be established in the United States. There are over 30 today. Like many of these it has derived its major support over the years by way of the regular university budgetary channels. While its support has been derived in large measure from the university, it has in no sense been a closed laboratory. Students and advanced investigators from all over the United States and indeed from many countries abroad, have been made welcome at these facilities. As an example of the breadth of its influence on graduate student training, 19 different educational institutions were represented in the group and over half of the students were from universities other than Washington. This is speaking of last summer specifically. It should be indicated that approximately 60 percent of the students at the laboratories from the University of Washington are nonresidents.

Senator SCHOEPPEL. Doctor, are they taking what would be designated as postgraduate work in this science?

Dr. FERNALD. These are all graduate students working for their masters or Ph. D. degress.

The scientific program of the laboratories today is conceived as serving a twofold purpose: (*a*) To provide for the training of graduate students in marine sciences—the course program is designed for the graduate student; only an occasional exceptional undergraduate can be accommodated. In addition, a very active program of supervised research for graduate students has developed. These programs often are, but need not be, a part of the students' thesis study. (*b*) To provide opportunities and facilities for research for advanced investigators from this country and abroad. No attempt is made to direct or to control the nature of the research undertaken except to require that it be oriented to the marine sciences. Copies of our brochure for the summer of 1961 are available to those interested.

The period of formal instruction is limited to a 10-week period in the summer. The teaching staff has been selected from qualified scientists from a number of universities in America and abroad—approximately one-half of this staff are from the University of Washington. Our facilities are distinctly limited in size, and for the current summer we have received applications from over 120 qualified graduate students for the 55 available spaces.

The CHAIRMAN. Doctor, of course you have no land problem up there?

Dr. FERNALD. No, sir.

The CHAIRMAN. It is the facilities?

Dr. FERNALD. It is a facilities problem, in terms of space. Our space for investigators for the summer is already oversubscribed. I am told that such crowding of facilities characterizes many another marine stations. Thus it becomes obvious that to meet existing needs, to say nothing of the future, new expanded shore facilities are required.

In response to this increased need for such facilities at the marine station, we are undertaking a modest program of expansion under the auspices of the National Science Foundation. Next month construction will begin on a new year-round research laboratory to cost $350,000. This new unit will expand and improve our research facilities considerably. However if, as is hoped, the number of long-term investigations is increased and more use is made of the laboratories during the entire year, this new addition will have slight impact upon the number of students and investigators to be accommodated for the summers only.

In the past more marine laboratories have been characterized by having such limited facilities, both in amount of space and in the nature of equipment and instrumentation, that only the observational sciences have been reasonably provided for.

The CHAIRMAN. Doctor, do you know offhand generally—or can you provide it for the record—how many universities or colleges, private or public, have marine laboratories such as—not on the scale of the University of Washington, but a distinct unit, such as the University of Miami, represented yesterday?

Dr. FERNALD. I believe it is indicated in a recent report that there are approximately 30 universities that have such. There are additional laboratories.

The CHAIRMAN. Most of them are comparatively new. Would that be a fair statement?

Dr. FERNALD. Yes, sir.

The CHAIRMAN. As the establishment of schools go.

Dr. FERNALD. In 1920 I believe there were only four university-associated laboratories of the type that I represent.

The CHAIRMAN. We can get a lot of testimony here, and I don't think we really need it, but the condition of these laboratories, when you consider the need for further research in marine sciences, is pretty limited all over, isn't that true?

Dr. FERNALD. That is correct.

The CHAIRMAN. It is typed; let's put it that way.

Dr. FERNALD. Yes, it is typed.

The CHAIRMAN. Even at the older laboratories, such as the Friday Harbor Laboratory, it is typed?

Dr. FERNALD. That is correct.

The experimental sciences have had to rely on approaches utilizing and improving from the simplest equipment. Lack of funds have made it essential that laboratories keep simplicity and flexibility as the keynotes of their design. In this age of advanced experimental research, specialized research space and equipment must be provided if we are to realize to the fullest the advantages of our marine facilities. On this point I take the liberty of quoting from a communication from a colleague speaking of his own area of special interest:

> The lamentable state of ignorance in the field of comparative physiology is not in the least due to the fact that the objects of its study are largely marine animals and that up to this time only highly improved facilities are available for their study. The great advances in physiology have been made in fields which are concerned with land living or freshwater animals; work on mammals and amphibia, and advanced work on crayfish, are examples. One must blame this situation upon the lack of specialized research space, specialized equipment and facilities at marine stations.

It is to be earnestly hoped that the future will make possible some amelioration of this lack which most certainly impedes development and extension of a number of areas in the marine sciences.

The CHAIRMAN. Doctor, wouldn't this also be true: Take Friday Harbor and the area in which you have been working. It has been limited because you have been out there doing it, until recently, comparatively alone. But I think what he is saying here, and what you are saying, is that if there were some kind of a broad program with objectives, that then the use of these laboratories, whether the stimulus be from any one of the departments that has a problem, or more basic research, or fellowships or grants, then this could be expanded into the fields of marine science in which we, as you say, are almost in the state of ignorance.

Dr. FERNALD. That is right. Laboratories of this type have been largely regarded as field stations and as such it has been considered that the equipment should be minimal and should be provided by the investigator and brought with him when he arrives. This kind of thing is very difficult in the present state of development.

The CHAIRMAN. It would be a great deal as if the University of Kansas, in the early days, would go into agricultural research, but would go out specifically by themselves in a small area.

Dr. FERNALD. Yes, sir.

The CHAIRMAN. But when there was a broad program by agriculture departments, or a national program, they expanded the grants. So therefore their knowledge became greater in that direction.

Dr. FERNALD. That is correct.

I have spoken specifically of the activities associated with the Friday Harbor laboratories. I should like to emphasize that while many of the other small marine stations are similarly developed and oriented, each plays a unique role in the advancement of marine sciences. By virtue of its specific geographic location and the opportunity for intensive investigation of its specific region, resulting in detailed characterization of its physical attributes and its specific fauna and flora, each laboratory can play a unique and significant role. I am gratified to see that this bill, S. 901, would visualize provision of support for selected shore facilities as a part of its program of expansion of research in marine sciences.

The CHAIRMAN. Doctor, our laboratory also has relations with the British Columbia group, does it not?

Dr. FERNALD. Yes; we have had in residence at the laboratory a number of the staff from the University of British Columbia. In fact one of the courses was taught for a number of years by Dr. Schedl from the University of British Columbia. We have a number of people there carrying on a continuing program of investigation using our facilities.

The CHAIRMAN. Even British Columbia has a pretty good research ship hasn't it?

Dr. FERNALD. Yes, sir.

The CHAIRMAN. Do we have any?

Dr. FERNALD. Not in association with the Friday Harbor Laboratories.

This is not a station in which the emphasis is toward open ocean work. That is handled out of the campus in Seattle.

Senator SCHOEPPEL. I would like to ask this question, Doctor. You have been in this field and you have a fine installation up there, and are one of the pioneers, in a sense, I presume, certainly on the west coast area—something that obviously has been considered much more important to the areas adjacent to the great bodies of water than in the inland institutions of learning, I can see that, though it doesn't mean that they are not interested in it.

With the assistance and with the impetus that is likely to be given to this, in your judgment would it be necessary for someone to make a determination as to where this assistance would be? In other words, we wouldn't want a lot of duplication?

Dr. FERNALD. That is correct.

Senator SCHOEPPEL. I know that you envisioned probably that scope of activity, and some reasonable approach to it.

Dr. FERNALD. Yes.

Senator SCHOEPPEL. How would that be determined? Would it be determined as you say in the last paragraph of your statement with reference to the characteristics of your areas or would it have to be channeled through some scientific group? How would it be handled? What would be your suggestion on it, if you would care to comment?

Dr. FERNALD. I think it would become necessary to have an advisory group, certainly, which would be able to evaluate on a national scale the importance of specific areas and specific developments. Some kind of organization of this sort, I think, would be necessary.

Senator SCHOEPPEL. And do you have a feeling—it is foreign to me, in a sense—that that can be done with reasonable satisfaction? In other words, no one wants to be precluded, I can see that.

Dr. FERNALD. That is correct.

Senator SCHOEPPEL. But to get the utmost in it at the beginning, it should be centralized in certain areas, it would seem to me.

Dr. FERNALD. Yes. There would have to be judgments made. As I have indicated here, each small laboratory can play a role. There have to be judgments in terms of how that role can best fit a general picture, I think, and the support in a sense determined on that basis.

I might comment on a statement you made in the beginning about the interest in the shore States in the marine installations. The inland States have an interest here in that most or many of the inland universities require or recommend that as a part of the advanced degree training in many of their biological degree sciences. A number of our students come from the inland universities—from the Midwest and so on.

Senator SCHOEPPEL. Thank you very much.

The CHAIRMAN. Thank you, Doctor. We appreciate your coming I will see you at Friday Harbor.

Dr. FERNALD. Thank you, Mr. Chairman.

(Biographical sketch follows:)

ROBERT LESLIE FERNALD

Address: Friday Harbor Laboratories, University of Washington, Seattle, Wash.

Major field of interest: Developmental biology.

Born: Larchland, Ill., August 27, 1914.

Degrees: B.A., Monmouth College, 1937; Ph. D., University of California, 1941.

Professional career: Instructor, zoology, Coe College, 1941–42; instructor zoology, University of Washington, 1946–47; assistant professor, 1947–59; associate professor 1959 to present; acting director of Friday Harbor Laboratories, 1958–60; director, 1960 to present: U.S. Navy, 1942–46.

Member: American Association for Advancement of Science, American Institute of Biological Science, American Society of Zoologists, and Western Society of Naturalists.

Scientific contributions in experimental embryology of amphibians, reproductive biology and development of marine invertebrates.

The CHAIRMAN. Dr. Roger Revelle is director, Scripps Institution of Oceanography, La Jolla, Calif. He has been before the committee before and we are glad to see him back on this legislation.

STATEMENT OF DR. ROGER REVELLE, DIRECTOR OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY, LA JOLLA, CALIF.

Dr. REVELLE. Thank you very much, Senator. I am glad to see that not only do we have our chairman from the great State of Washington, where I was born, but also the Senator from the State of California, where I worked and spent most of my life.

The CHAIRMAN. And you have probably gone through Kansas on several occasions.

Senator ENGLE. Thank you very much, Doctor; it is good to see you here.

Dr. Revelle. I am appearing today as the representative of the Committee on Oceanography of the National Academy of Science. Some of the other members and associates of this committee are also here this morning, and they will discuss some of the new features of the Magnuson bill as oceanographers have come to call the Marine Science and Research Act.

Dr. Ewing, of the Lamont Geological Observatory, will tell about the need for long-term laboratory support.

Dr. Ray, of the University of Washington, will discuss some of the medical aspects of oceanography. Jim Snodgrass, of the Scripps Institution, and Allyn Vine, of Woods Hole, will talk about instruments and new devices.

Dr. Schaefer, of the Inter-American Tropical Tuna Commission, will review some of our recommendations on research needed to develop the living resources of the sea.

I shall talk about three aspects of the national program in oceanography: the needs for laboratory facilities; education and training; and for coordination, sustained growth, and leadership.

A. Laboratory facilities: Recently, the members of the Committee on Oceanography reviewed chapter 1 of their report, "Oceanography 1960–70." This report was first published a little over 2 years ago. In making this review, we discovered that we had underestimated the total funds necessary for shore facilities for oceanographic research. Our 10-year estimate of capital costs for basic research laboratories of $16,500,000 was tied to the proposed construction of new research ships, and the consequent need to build additional shore laboratories to accommodate the additional personnel, scientific personnel, who would use those ships.

The Chairman. How many ships does Scripps operate?

Dr. Revelle. We now operate eight ships.

The Chairman. And how many belong to the Institute and how many are loaned or under charter or some other arrangement?

Dr. Revelle. Four of the ships we operate belong to the Federal Government. These include the big ship *Argo*, which is about 2,000 tons, and which is just returning from a voyage, from an expedition to the Indian Ocean; the *Spencer F. Baird* which is a ship of about 700 tons, and which has been used to cover a very large part of the Pacific during the last 8 or 9 years; the *Paolina T*, which is a converted purse seiner bought by the Bureau of Ships; and an Army T-boat, a little 65-foot cargo carrier built by the Army during the war.

The Chairman. We can put that in the record, but the point I want to make is what is the newest one of these ships? How old is the newest one?

Dr. Revelle. The newest one is 20 years old.

The Chairman. The newest one is 20 years old?

Dr. Revelle. Maybe not quite 20. About 18 years old, in terms of when it was built. Of course, they have all been modified and converted. The oldest one is about 25 or 26 years old.

The Chairman. You are generally familiar, as I am, with some of the Russian ships.

Dr. Revelle. Yes.

The Chairman. There is no comparison?

Dr. Revelle. The Russian ships, the big ones, the ocean-going ones, high seas, blue water ones, are in general much bigger than ours.

The Chairman. And modern.

Dr. Revelle. Some of them are modern, some are not. The *Vityas* is an old conversion.

The Chairman. Even on the converted ones, I can tell the committee, the equipment is modern.

Dr. Revelle. That is true of ours, too, sir. Ours are much smaller than the Russian ships. We are not convinced that we need ships as large as the Russians. They do things on a very large scale.

Senator Engle. I was out last year in a ship operated by Captain Hancock. Are you familiar with his operation?

Dr. Revelle. Yes.

Senator Engle. How is that correlated with other oceanography work such as done by the Scripps Institute, if it is?

Dr. Revelle. The ship that you are referring to was the *Bowler A–4*, of the Hancock Foundation of the University of Southern California.

Senator Engle. That is correct.

Dr. Revelle. It is a ship used primarily in coastal waters off the California coast. It has done some very good work there. Occasionally it goes off to the Lower California coast and into the Gulf of California. Ships of the Scripps Institution, like the Lamont Geological Observatory and the Woods Hole Oceanographic Institution, while it does a good deal of coastal work, are primarily concerned with exploration of the oceans as a whole. This is why we operate such a big ship as the *Argo*, and these fairly big ones, converted tugs. This really illustrates the point, Senator, that we are dealing with a very complicated part of the earth which requires different kinds of facilities, different kinds of operations, and even in some sense different kinds of people to study different parts of it.

Is this a reasonable answer to your question?

Senator Engle. I got the impression that Captain Hancock's operation was primarily in surveying in areas close to the shoreline.

Dr. Revelle. That is correct.

Senator Engle. He did have equipment on there to take samples off the bottom. In fact, he did that while I was out with him. What I was trying to determine is how you keep from overlapping or duplicating in this type of work. Is there any correlation any place?

Dr. Revelle. There is a great deal of correlation. Science operates by people talking to each other. In the case of the Hancock Foundation, for example, we are continually in communication with them; we are with individual scientists on their staff. We don't try to coordinate our work at the level of the directorate, but rather at the level of the individual research problems and research projects. To worry about duplication under these circumstances is to worry about something which really doesn't exist, which can't exist, which couldn't exist for many years to come, because there is so much to do.

Every time you go to sea you find out a lot of things that nobody ever knew before. The interest of the people at the two places differs sufficiently, and their ways of working differ sufficiently so that we don't have overlaps. What we have are great holes in our knowledge which are not covered.

Senator SCHOEPPEL. In the correlation of this data, in your exchange of your ideas, in the exchange of your scientific developments, do you find at this early stage of it that we are having quite a bit of cooperation from certainly our friendly nations and people who are interested in it?

Dr. REVELLE. We are having a great deal of cooperation with all of the scientific countries of the world, Senator.

Senator SCHOEPPEL. Does that go for the Russians?

Dr. REVELLE. Including the Russians. This was largely the result of the International Geophysical Year.

Senator SCHOEPPEL. I was wondering if that might not stem from that.

Dr. REVELLE. Largely because of the International Geophysical Year, scientific cooperation with Russia as well as with other maritime powers—England, France, Japan, Germany, Scandinavian countries, several of the South American countries, India, and many other smaller countries—is developing very rapidly at the present time. This gives us real hope that we can make maps of the oceans and make an adequate survey of the oceans through international cooperation which might not be possible, and we don't believe would be possible, through the efforts of any one country.

For example, a few years ago we, in the North Pacific, had a cooperative program of mapping the entire North Pacific north of 20°; not the bottom, but the temperature and salinity and other properties of the water in the upper 3,000 feet of the water column during 1 month, what we call a synoptic survey. Mr. Joseph Reid, who is here today, was the man who organized and directed this program. As I remember it, there was something like 20 or 25 ships altogether which took part in this. About half of those were Japanese, the rest were Canadian and American ships.

This kind of cooperation in making simultaneous observations, for example, by the ships of many different countries, is the only hope we have at the present time of being able to do what the meteorologists have long done in the atmosphere, to make maps of what the ocean is like, or to take a kind of photograph of what the ocean is like at any one time.

Senator SCHOEPPEL. Thank you.

The CHAIRMAN. Go ahead, Roger.

Dr. REVELLE. I was talking about the need to construct additional facilities, and I was saying that in our report we simply thought about what would be needed to provide laboratories for the additional people to man the additional ships. What we overlooked was the fact that very little oceanographic building has been done during the last 20 years. The result is that both the major and minor, or the bigger and smaller laboratories, are now very overcrowded. It is literally impossible for most of them to expand at all in terms of people, without additional space. People are sitting in each other's laps. This is a particularly critical matter as far as training more young people is concerned. There just isn't any space to put them.

One of the reasons for this is that as we learn more about the basic sciences, we are using more complicated and larger and more delicate instruments which just require more space. When Dr. Fleming and I were young students—Dr. Fleming of the University of Washington—we used to say that any oceanographic instrument should have less than one vacuum tube per unit per instrument. Now all the young people who work at our places wouldn't think of lowering something into the water which just wasn't chock full of electronics. This just means an awful lot more shop space, a lot more space for technicians, a lot more complicated gadgetry of all kinds, and this just requires a lot of space.

Sometime during the morning I hope Mr. Snodgrass, of our institution, and Dr. Ewing, of Lamont, will show some pictures of some of the space situations at our two laboratories.

Yesterday you heard from Dr. Pritchard, of the Johns Hopkins University. Dr. Pritchard was forced to build a mezzanine around the walls of an office about as big as an average family living room to provide office space for his overcrowded staff. The height between the floor of the mezzanine and the ceiling is only about 5 feet. When I climb into it I have to practically kneel to stay there. Yet they have to do this because his facilities are so overcrowded. The single building housing the department of oceanography at the university has not been enlarged since it was built in 1930, although the staff, responsibilities, and budget of that fine institution have been expanded several fold.

In your bill, S. 901, the funds authorized for the National Science Foundation for the construction and operation of laboratories for basic research are identical to funds recommended in our original report. We must confess that our report was much too low. Therefore, one specific recommendation that I would make this morning, sir, is that if the National Science Foundation is authorized to supply half the needed funds for research facilities, as recommended in our report, the total allotted to the National Science Foundation for this purpose should be greatly increased.

B. Education and training: The need for new shore laboratories is particularly critical in order to foster the education and training of oceanographers. An adequate teaching program requires both ships and shore-based facilities, and both are in short supply. Few institutions can materially increase their present number of students without either obtaining better physical facilities or reducing the space and ship time that is used for research.

One of the very encouraging things during the past 2 years is that we are having a virtual flood of applications for graduate study in the marine sciences. For example, at the Scripps Institution the number of graduate students in the marine sciences, physical and chemical and geological oceanography and marine biology, all lumped under the broad head of oceanography, has increased from about 43 last year to 70 this year, and during the coming year, if we had the space to do it, we could double the number of graduate students. We just can't do this because we haven't got the space. We are only going to be able to take about 20 new students this next year, which will be actually, in terms of increase, only about 7 or 8 new students.

In other words, we are only able to add a very small percentage of students simply because of lack of space. Yet the bright young people are there, and they are coming in in wonderfully encouraging numbers and with very evident ability and good training.

The CHAIRMAN. I think that probably all of these interests in marine things are usually not self-started with young people, and I think that perhaps the work of many people in this room, and perhaps some of us up here, during the past 3 or 4 years, has done a little to call attention to this field which was sort of dormant for awhile.

Dr. REVELLE. I am sure that this is true, sir. With the very evident congressional and Federal interest helping.

The CHAIRMAN. The interest of the National Academy, you people, are the ones who started it.

Dr. REVELLE. Yes; it has helped a lot. It is also because we are getting more people in this country, and more people interested in science. It is also, I think, because there is a growing realization that these sciences that deal with the environment are not only very important but an awful lot of fun, that it is a wonderful way to spend your life.

I must add, however, that we still have a great shortage of trained people. That is particularly true in what we call physical oceanography, that is the study of the currents, the motions of the waters, and the chemical and physical properties of the waters. It is also true in marine biology; really in every aspect of marine biology, but particularly in the study of the life histories, the classification, the shapes, and distribution of marine organic items.

Both of these points that I have tried to make so far illustrate something about the National Academy report which I know you will all keep in mind, and that is that this report is not intended to be a blueprint but simply a kind of a framework illustrating what could be done and what needed to be done. No member of the National Academy of Sciences, and certainly no member of this Committee on Oceanography, is either a seer or a prophet. All we could do is estimate as best we could what the needs were and what the possibilities were. So I do hope that in any legislative action that you won't take this report too literally as a kind of a straitjacket.

The CHAIRMAN. A guideline.

Dr. REVELLE. It is essentially a statement of possibilities and the needs.

The CHAIRMAN. Roger, on page 4 of your statement, I think you get right to the meat of the thing. I think we all understand this problem of personnel and laboratory facilities. I think you get to the meat of that at page 4, at the top of the page where you quote a portion of the bill and what has been done and what we should go on to do, which is, of course, again a guideline. I would like to have you read that section of your statement.

Dr. REVELLE. C. Cordination, sustained growth, and leadership: As so well stated in S. 901—

> there must be a coordinated, long-range program of oceanographic research and marine surveys * * *

We are not proposing a crash program such as faced the Nation at the start of the space race. We are proposing instead a sustained and adequate growth to meet serious scientific, resource, and military needs.

1. Some significant steps forward have been taken during the last 2 years:

(*a*) Funds for new ships have been allocated.

(*b*) The National Oceanographic Data Center has been formed.

(*c*) The Interagency Oceanographic Committee of the Federal Council of Science and Technology, and the President's Science Advisory Committee have done a great deal of effective coordination in the programing and budgeting of oceanic investigations by different Federal agencies.

(*d*) An international oceanographic organization, to be called the Intergovernmental Oceanographic Commission, corresponding in many ways with the World Meteorological Organization, is being established under the sponsorship of the Specialized Agencies of the United Nations.

The CHAIRMAN. This is in the general field of the Geophysical Year?

Mr. REVELLE. No, sir, this is new.

The CHAIRMAN. New? As a result of the Geophysical Year, probably.

Mr. REVELLE. It is a result of the National Academy's work in large part, actually. The Geophysical Year had something to do with it. These are all things that have happened within the last 2 years since our report was published.

2. A good deal more needs to be done, and soon.

During the next few years we can and should take giant strides to meet our national responsibilities and opportunities for using the oceans.

(*a*) We must build many new (and carefully designed) ships to replace old obsolete ships and to add to our total national fleet for exploring the oceans.

(*b*) We must build many new laboratories, instrument shops, piers, and classrooms to accommodate the present overcrowded marine laboratories and to make room for the many bright young scientists who are even now flooding our oceanographic centers with applications.

(*c*) We must develop and produce in quantity a whole new arsenal of instruments that will bring the best of modern technology to grips with the herculean task of understanding and exploring the sea.

(*d*) We must provide funds at once for training new oceanographers.

(*e*) We must plan and carry out a program of oceanwide surveys to map the ocean floor, the properties and movements of the waters, and the distribution of living creatures. In this connection I have already said that in my opinion this can only be done effectively through international cooperation because the task is so large. Our maps of the ocean floor, for example, are quite comparable in accuracy and in detail to the maps of the land surface that we had about the year 1720.

The CHAIRMAN. Doctor, you will remember that about a year and a half ago, when you had the international meeting in New York, some of your colleagues from other nations came down here and had an informal discussion. In that discussion we considered the future in the field of antisubmarine warfare, undersea defense, and at that time the emphasis was not as great as it is today in that field, whether it be a potential enemy or whether it be just nations building up their own defense. You were absolutely right about this problem of mapping the oceans and knowing the currents, as it relates to undersea defense or warfare, whichever you want to call it, and in suggesting that there would be some great advancements in the depths of undersea submarines, and scientific devices; also in ocean platforms.

Only the day before yesterday I attended a meeting, classified to some extent, in which they were talking about exactly what we discussed, not to the same depths, but pretty deep. That is moving even faster than we are moving in having the maps or preparing the information that is necessary for operations of this type.

One of the justifications for this program is that the least we can do is keep up with that, keep abreast of it. I don't know that we are going to be able to do that. It is moving awfully fast.

Dr. REVELLE. It certainly is.

The CHAIRMAN. And in the field of small undersea craft, also. We surely know that the Russians are doing exactly the same thing.

Dr. REVELLE. There is a real question here, which is often raised from a military point of view: Is it desirable for us to exchange information with the Russians?

My own opinion is that it is, and the reason that it is, is that the side that has the best technology can use knowledge most effectively. If we can get on a quid pro quo or any exchange basis the knowledge that the Russians are getting and if we can be sure it is of the quality of the knowledge that we are obtaining, I am sure it will do us a lot more good than it will them.

Moreover, maps are the kind of thing that you can't keep classified, anyhow. The problem then is just to make them as fast and as good as possible. All of these surveys I think should be unclassified, and if they are unclassified it is very much to our advantage to cooperate with other countries, with all the other countries.

The CHAIRMAN. The necessity of coordination in this field is also pointed up by the fact that I know, and the other Senator from California knows, that some of the real priorities in the Defense Department, things to do, get into the field of oceanography, in which we are behind.

Go ahead.

Dr. REVELLE. We were just talking about surveys. As I stated, I feel these are very important. What I mean by this is simply systematic mapping, using known techniques. This is not really research.

What we need in addition, of course, is what scientists call basic research, which means understanding the processes and the nature of the ocean, the ways of life in the sea, which there are so many different kinds of creatures in the sea, where do they live, why do they live there, how do they move, how do they behave, how are their populations affected by different things that happen in the oceans, what is the relation between the ocean and the atmosphere, how does the ocean affect climate, why does the ocean exist, why does the bottom of the ocean have the shape it does, why doesn't it look like the surface of the moon, what is beneath the sea floor; the kind of thing, for example, that is being found out right now by the great Project Drill, beneath the sea floor. These are all projects in basic research, and this is by far the most important thing that we need to do.

The CHAIRMAN. It all adds up to a better understanding of this for defense.

Dr. REVELLE. In order to do the research we also have to make the maps.

It seems to me that there is a real opportunity that we should seize at the present time. We have spoken about the favorable climate between Federal and State administrations, the high degree of public interest and response, the more and more widespread scientific interest, the fact that our own congressional interest is turning to the sea, and the unanimous passage last year of S. 2692 and the introduction this year of S. 901 and various bills from the House is strong evidence that it is the will of Congress that our Nation embark upon an expanded, coordinated, continuing oceanographic program.

The CHAIRMAN. I don't suggest that there was a lack of interest in the executive department in the past 8 years, but I do suggest from the conversations that I have had that there is a greater interest in this field at present than there was 2, 4, or 6 years ago.

Dr. REVELLE. A greater realization.

The CHAIRMAN. And the needs become greater.

Dr. REVELLE. In order to accomplish these objectives, we must provide for a way of assuring continued development and coordination of this complex enterprise.

A. S. 901 has just this objective as its primary thesis, and a bill has been introduced recently in the House with a somewhat similar objective.

B. While I am not an expert on legislation, there is a feature of both these bills with which I agree—although at first glance the bills are quite different; that is, the Senate and House bills. Both provide for a continuing coordinating body with responsibilities for policy, programs, interagency coordination, information exchange, and evaluation of progress in the program. There are several possibilities for such coordination.

One possibility is what you have suggested, and that is the possibility of the establishment of a body within a Federal agency such as the National Science Foundation, as proposed in S. 901 with responsibilities for review, planning, and coordination.

Another possibility might be the establishment of a National Bureau of Oceanography, or a Bureau of Marine Sciences.

For a good many reasons I believe that neither of these is a desirable solution. Let me state my reason, or the principal reason.

Oceanography is not a science like physics or chemistry or zoology. It is the application of many sciences to the study of most of the earth.

Many Federal agencies in carrying out their mission have to know more about the oceans than they now know. It is true of the Navy; it is true of the Weather Bureau; it is true of the Coast and Geodetic Survey; of the Bureau of Fisheries——

The CHAIRMAN. Conservatively, we have 16 Government agencies that are directly involved in this field.

Dr. REVELLE. That is right. And it would just impose another layer of bureaucracy if you should say that all of these needs should be met by a central bureau. AEC, for example, has special concerns and special needs for certain kinds of knowledge which is quite different from the Bureau of Commercial Fisheries knowledge.

The CHAIRMAN. Of course, we don't know that this is exactly the way to handle it, and there may be a lot of other suggestions made as we move along, but as of now you would favor the suggestion in the legislation that the National Science Foundation be given the responsibility for the review, planning, coordination, and so on and so forth?

Dr. REVELLE. I am not sure that I would, Senator.

The CHAIRMAN. Give us your ideas.

May I suggest this: You have called attention to two or three alternatives or possibilities. There is the suggestion which has been made that this might be done by the establishment of something similar to what we did last year in the Appropriations Committee, take steps to set up a National Center for Atmospheric Research. That is another alternative suggestion.

Dr. REVELLE. Yes, that is right. So we really have four suggestions, including the three that I have listed here.

I would personally reject the national institution and the reason is simply—there are several reasons—one being that national institutions already exist in the form of Woods Hole, Lamont, the Scripps Institute, and many smaller laboratories.

Secondly, a national research institution, apart from universities, just is not a very effective way to do the job of research.

Third, of course, is that we have right now many effective groups within the Government which are doing both research and surveys, and what is needed is coordination of their work and strengthening of their work.

The CHAIRMAN. This has got to be a part of any plan that we have, the correlation of agencies, regardless of the plan we have.

Dr. REVELLE. That is right.

The CHAIRMAN. In beefing that up, I want to get away from government in the thing, so that we would have some outside input. Dan Markel made a study, and we have found that probably the most successful such project as this has been in England, for instance, where the Government and outside groups work together in a sort of committee.

Dr. REVELLE. Yes; this is certainly a possibility. At the present time coordination has been quite effective.

The CHAIRMAN. No one is complaining about it. It has been good.

Dr. REVELLE. The way it works is this: Under the Federal Council on Science and Technology, which as you know was established by Executive order, there is an Interagency Committee on Oceanography which is made up entirely of representatives of the different Government departments. And this Interagency Committee is in continuous communication with the National Academy of Science, the Committee on Oceanography. Several representatives of that Committee meet with the National Academy Committee and I think that at least on a limited level the reverse is also true, that representatives of the National Academy Committee meet with the Interagency Committee.

The CHAIRMAN. Yes, they could meet with them and have complete coordination with them. I think one of the problems is whether they should be separate, the interagency be separate or put together.

Dr. REVELLE. Or at least be closely interlocked.

The CHAIRMAN. Or interlocked in some way. I think the whole situation indicates some kind of interlocking, but dealing with Government agencies and only Government agencies alone has some serious complications, too, because some agencies have a tendency to stay by themselves, and then their budgetary problems became serious.

Dr. REVELLE. I am kind of puzzled by what kind of coordination is best here. It seems to me that there are two things that are quite important, and that is that whatever body exists should report to the Congress as well as to the executive branch.

Another thing that we run into is that the Interagency Committee proposes and approves and blesses an oceanographic budget for the different agencies, but this somehow never gets all the way through the budgetary processes.

I don't quite understand how you overcome this. That is, the Bureau of the Budget, or perhaps the department level of the departmental secretaries, the plans of the Interagency Committee seem to be very seriously cut down.

The CHAIRMAN. The trouble with the thing is that suppose everybody on the Interagency Committee agrees that you want to go ahead with the program. Take the Bureau of Commercial Fisheries. The Interagency Committee as a committee decides that a certain program should be recommended. So the Bureau of Commercial Fisheries takes it to the Interior Department with the blessing of the Interagency Committee, and maybe an advisory committee, such as the bill provides. But when they get there they immediately get mixed up with the priorities of the Interior Department, of which there are many, and of which oceanography or fisheries, to use that as an example, are orphans. Fisheries long has been an orphan as far as the budget is concerned. This is the sort of problem which has to move through the Department as a separate entity. In other words, not to get mixed up with the priorities of the Land Management or of the Bureau of Reclamation and all these things. In some departments it is all right. I suspect that Navy doesn't have too much trouble.

Dr. REVELLE. They have a lot of trouble.

The CHAIRMAN. But not as much as the rest of them.

Dr. REVELLE. There is a great conflict.

The CHAIRMAN. This is the sort of thing which bogs down a program which everybody agrees upon.

Dr. REVELLE. The Navy has a problem between the "do it now" men and the "long range" men. Some people want another destroyer and others a research ship.

The CHAIRMAN. The National Science Foundation, the work they have been doing would have been 20 years behind if we had run what they are doing through each agency that is involved. But because we set up in the beginning a National Science Foundation that puts it out to the agencies, it has worked. The agencies would have been 20 years behind and would never have gotten off the ground if it had been done the old way.

These agencies, in oceanography, have done a great deal since we started this 3 or 4 years ago, and are moving pretty fast. But we still have those pitfalls of trying to run it through the various agencies involved without any coordination.

This is an administrative problem that we have in the bill, I appreciate.

Dr. REVELLE. What I thought is that by having this committee set up by statute and reporting to Congress, as well as to the executive branch, in effect it would have a way of bypassing the Bureau of the Budget, at least in part. Not totally, and it is not desirable, but it should have some voice.

The Chairman. Nobody wants to bypass the Budget, but if we are going to embark on a program of oceanography, it ought to stand on its own feet with the Bureau of the Budget, with whatever department is participating. But the way it is now, even though we have moved ahead a great deal, it just can't stand on its own feet.

If anybody in this room who has never been mixed up in this thinks it can, they are mistaken. It gets involved in everything else in that department, and usually its priority is pretty low.

Dr. Revelle. It doesn't give it any immediate benefit. It is long range.

The Chairman. That is correct. Usually they will say this can wait, and maybe something will happen accidentally.

Dr. Revelle. I think the only recommendation that I would be willing to make is a very wishy-washy one, and this is simply because I just don't know enough about it; it is not my business.

I think it is quite important that coordination should be developed; I think it is important that a way be found, as you say, for the oceanographic work to stand on its own feet and not to be confused with other priorities.

I would like to suggest very respectfully that maybe you have access to some experts in this field, perhaps the Library of Congress Legislative Reference Service, that might make a careful study of all of the possible ways of doing it and what would be the consequences.

The Chairman. They could start with a director of oceanography and give him full power, and then the program would be going. Or you could start on the other extreme and suggest a broad program, and let every agency handle it by themselves. I am speaking of their budgetary problems, not coordination or exchange of information.

Dr. Revelle. Then it falls between the various schools.

The Chairman. That would put it way back, and we would be back 5 years from now wondering why we had not moved ahead. But someplace in between is the type of thing we want, I think.

Dr. Revelle. That is correct. I think all the oceanographers would be agreed that there are two things that they don't want, that they don't really think are desirable. One is a bureau, a director, as you say, who handles all the oceanographic work; and the other is a national institution such as set up in the atmospheric sciences.

The Chairman. Nobody wants to be directed to do these things, but you have to have some sort of coordinating unit or group or board or advisory body, so that when it is decided that this is the sort of thing we want to do with research or with the facilities or grants, whatever it may be, that it can help them proceed with it and get going.

Dr. Revelle. I think it has to be done in the context of a knowledge of what a study of the ocean means.

The Chairman. Those are things that I think we can work out. There may be some trial and error involved here, which is true of all of these things.

Dr. Revelle. There has been a lot of criticism, I think, of the fact that the National Academy Committee has proposed what seem like relatively large expenditures in what seems like a relatively small science. People say that this is only one of many sciences: What about nuclear physics? What about solid state physics? What about inorganic chemistry, molecular biology, every possible kind of science? What I would say is that oceanography isn't really a science, that what we are concerned with here is a very large part of the earth, and a part of the earth that is of infinite importance to the United States because we are the world's largest island. And so we really do have to have some kind of a special point of view and a special development which will lead to our making a wiser and better use of the oceans.

The CHAIRMAN. Space wasn't a science.

Dr. REVELLE. The same thing applied to space. Space, atmospheric sciences, oceanography—these are all the same.

The CHAIRMAN. We had to get together a lot of people.

Dr. REVELLE. One of the interesting things that is happening——

The CHAIRMAN. I handle the appropriations for the Space Agency, and I am a member of the Space Committee, and I have gone through this. Do you think that we would have moved in space as we have—I don't know if we have a gap or not; that is debatable—if we had let every department go by itself? That is the way we started out. I have had that experience. Some things had to give some place to get this going, and, of course, some people didn't like it.

Now when we want to go out in space, to appropriate money, there is a correlation, a coordination, and we have the backing of the Department involved in this, which is not mixed up with the priorities of the other departments. That is what I am trying to do in oceanography.

Dr. REVELLE. I might conclude, Senator, by following up on your last point.

I think there is a growing realization among all the peoples of the world that we have to use our whole planet better than we are using it now. It is quite ironic that this is happening at the same time that we are learning how to leave the planet altogether to go out into space. But our human populations are increasing so fast, and we are using up our easily won resources so fast that man's future will be pretty bleak and dim if he can't achieve some kind of harmony with his own planet. And this harmony has a profoundly human meaning, also. We are the creatures of earth, and it doesn't really matter how far we venture into space, or how much we find out about other worlds or about other creatures on other worlds. I think that just because we are biologically the creatures of earth we are always going to return to earth and to think about it as our home. It is a unique home, largely because it has oceans.

For example, in the solar system there is no other planet that has both oceans and dry land. The green hills and the blue seas of earth are unique to the earth. It is the green hills and the blue seas which is the environment in which men evolve and in which men have lived for countless generations. Because of our emotional and spiritual nature, this will always mean more to us than anything else.

One implication of this inevitably is that we just have to know more about it in order to treat it kindly and reverently and to use it well at the same time. Of course, the very largest part of it is that part which is covered by sea water. It is this part which we know least about and which in many ways affects all the rest.

For example, one of the things which greatly limits where people live and how they live is the climate on the land surfaces. In order to use the earth more effectively we have got to be able to do something about climate; we have got to be able to make the deserts habitable; we have to be able to make the tropics more habitable; and the regions at high latitudes more habitable.

I myself am convinced that we will be able, eventually, to be able to do something about our climate. But in order to do it we are going to have to know a whole lot more than we know now, and part of the knowledge that we have to have is the knowledge of how the oceans and the atmosphere work together as a complicated steam engine.

It is quite impressive to think about the history of our human species. We have lived on the earth for about 500,000 years. People lived on the earth a hundred thousand years ago; many of them were just as smart as anybody in this room. But it is only within the last 2,000 years or 2,500 years that anybody has thought of the earth as a whole.

There was an interesting story in Time this week about the country of Laos, in which it said that everybody in Laos still thinks that the earth is flat and most of them think that it is inhabited entirely by Lao. They have the vision and point of view which every human being had only a few short generations ago.

Senator SCOTT. It was the sort of prewar attitude in a large part of the United States.

Dr. REVELLE. Yes, sir. All of a sudden this has changed. We now think of the earth as a whole. Men everywhere are thinking of the earth, civilized men everywhere are thinking of the earth as a whole, realizing that it has to be treated as a unit. It is this emphasis on the environment in which we live, on our relationship to our modern earth in which the ocean is the placenta fluid of life that really is the basic drive which is impelling us all to obtain a greater understanding and a greater knowledge of the oceans.

Thank you very much.

(The biographical sketch of Dr. Roger Revelle follows:)

ROGER RANDALL DOUGAN REVELLE

Address: Scripps Institution of Oceanography, La Jolla, Calif.

Major field of interest: Oceanography.

Born: Seattle, Wash., March 7, 1909.

Degrees: A.B., Pomona College, 1929; Ph. D., University of California, 1936.

Professional career: Research assistant oceanography, Scripps Institution of Oceanography, California, 1931–36; instructor, 1936–48; professor, 1948; associate director, 1948–50; acting director, 1950–51; director, 1951–.

Committee membership: Special Committee on Oceanic Research of the International Council of Scientific Unions; National Academy of Sciences Committees on Oceanography, Amphibious Operations, UNESCO, and Marine Ecology, and Navy Research Advisory Committee.

Society membership: American Geological Society, Association of Petroleum Geologists; American Society of Limnology and Oceanography; American Geophysical Union; America Meteorological Society; and Oceanographic Society of the Pacific.

Scientific contributions in physical oceanography and geology of the sea floor.

The CHAIRMAN. Are there any questions?

The Senator from California?

Senator ENGLE. I want to compliment the doctor on an excellent statement.

The CHAIRMAN. Thank you, Roger.

Senator SCOTT. I want to thank the doctor, as a graduate of a 1-day course at the institute when I was in the Navy. I didn't exactly qualify as an expert in that 1-day course, but I have an idea of what your facilities are, how limited they are.

The CHAIRMAN. Dr. Fish, we will be glad to hear from you. Dr. Fish is director of the marine laboratory, University of Rhode Island.

Doctor, you have a short statement. We will be glad to hear from you.

STATEMENT OF DR. C. J. FISH, DIRECTOR, NARRAGANSETT MARINE LABORATORY, UNIVERSITY OF RHODE ISLAND, KINGSTON, R.I.

Dr. FISH. Mr. Chairman and Senators, I am grateful for the opportunity to appear before this committee. I am Charles J. Fish, founder and director of the Narragansett Marine Laboratory of the University of Rhode Island. I am also an associate of the Woods Hole Oceanographic Institution. My experience in oceanography extends over a period of 39 years.

In hearings on the previous Senate bill S. 2692, members of the Committee on Oceanography of the National Academy of Sciences and special panels of the Committee representing different fields of marine science have explained the need for a comprehensive 10-year program of oceanographic research and training of scientific personnel to provide an essential basis for national defense and exploitation of the natural resources of the oceans. I concur completely with their conclusions and recommendations, and the objectives of the present bill.

Today in support of S. 901 I wish to discuss small oceanographic laboratories with university affiliations, their importance and needs. To conserve time I shall not dwell on our own laboratory, which is experiencing the same problems described yesterday by Doctors Pritchard and Idyll.

Since World War II numerous small marine laboratories have been created and attempts made to enlarge older ones. Most, however, have been restricted to estuarine programs because of insufficient trained oceanographers, limited funds, and lack of adequate vessels for offshore operations. This has resulted in a concentration of open ocean programs and Federal support for them in a very limited number of large laboratories. To escape the danger of unwieldiness in these few large institutions and to avoid the possible necessity of the military itself having to undertake basic oceanographic research, which might be handled better by civilian agencies, more oceanographers and different laboratory facilities are urgently needed.

Here, university marine programs are most important. However, lack of balanced faculties has encouraged disproportionate emphasis on specialized training and research determined usually by the qualifications of the local staff. As a result, although excellent progress of a specialized nature is being made, there is as yet inadequate research and educational preparation for investigation in major oceanographic problems of more general character involving essential relationships between the different components of ocean populations and their environment, particularly those requiring group effort and correlation of physical, chemical, biological and, in coastal waters, geological factors. Thus, although the marine biologist, for example, may confine his attention to a single species or even individual organism the biological oceanographer, concerned with the interaction of biological processes and environmental variables involved in the production, distribution and fluctuations of populations, cannot profitably operate alone, and should have basic training in physical, chemical, and geological oceanography. For this university marine laboratories will need added personnel. To attain them, over rapid growth at a sacrifice of high standards and time-consuming technological services, which restrict basic research effort, should not be necessary. The proposed Division of Marine Sciences in the National Science Foundation would provide an effective means for decentralization of Federal support and coordination of effort.

Added buildings and vessels will also be needed to expand the scope and area of operations. It is not proposed that each university laboratory be equipped with a large research vessel and attempt to encompass an entire ocean in its program. This can best be left to the larger institutions able to participate in international cooperative projects.

If provided with smaller, but seaworthy vessels of approximately 500 tons or more, university marine stations could extend their research and training programs from estuarine waters seaward over the Continental Shelf and slope. These two areas are the least understood and together with the inner estuarine zone support the greater part of the marine life utilized by man.

The inadequacy of American oceanographic information during World War II, contrasted with that previously acquired by the enemy, proved a serious disadvantage to those concerned with the operational aspects of undersea—mine and submarine—warfare. When I located the Japanese Navy's oceanographic records at the end of the war it was found that up to 55 vessels had operated from 1929 until 1943 in a carefully coordinated oceanographic program covering the Pacific and Pacific arctic waters. The coastal prefectures, corresponding to our coastways States, were provided with small laboratories and seagoing ships by the Japanese Government, and the Government coordinated this program so they operated continually, getting a wealth of information which was most useful.

The CHAIRMAN. Doctor, to illustrate how far behind we were, I can illustrate an experience that I had during World War II. I got liberty leave to come back to the mainland and I was called by the Navy Department and asked if I wouldn't go up to Alaska and find about four fishermen who had fished the Aleutian Islands. I was given authority to commission them, because we didn't have charts of the Aleutian Islands. The Japanese were in Kiska and Attu. I got four fishermen, gave them commissions, and they literally stood on the prow of the warships and guided them. This is how far behind we were.

Dr. FISH. I can understand that.

Insufficient information on the character and rate of fouling growth could have been very costly in our own coastal defense. It is believed that all except one of our coastal moored minefields were rendered inoperative within a few months. Fortunately the enemy was not aware of this.

Senator SCOTT. May I comment on that. Our plans for the invasion of the Japanese mainland involved landing in three separate landings: in the lower part of Kyushu, at Kogoshima in the center, and on the outside of each side of the peninsulas, with the 3d, 5th, and 7th Amphibious Forces. You say more coastal minefields might have remained inoperative. Such a situation could well have caused considerable casualties, could it not, in the course of those operations?

Dr. FISH. Yes, sir. We put confidence in it. Luckily the enemy didn't know it, and as far as we know none of them attempted to cross them. But the field at Hatteras and Key West, we did get ships, they were our own. But the field at Trinidad did stay alive longer, the reason being that the fresh water from the Orinoco prevented fouling growth on it, and the mines held position. The same thing has happened elsewhere. The fields off Casablanca were all laid down on to the bottom by fouling growth on the cables and on the mines. It is most important to know where and when fouling will take place so that you can predict the useful life of such weapons as mines.

Senator SCOTT. I recall as an intelligence officer how little information we had on minefields, even on the character and types of mines, on the underwater areas where they were used, the nature of the whole mine operation, which was very largely speculative. We knew where virtually every Japanese warship was, but we had far less information on the mining situation.

Dr. FISH. This information from coastal waters has very direct application, and I feel that it is something that the university marine laboratories can develop very well. I could talk for the rest of the day on the savings that the brief information that we had made possible in the Navy, such things as the Y Star mines—that is a German magnetic mine—which started appearing around Trinidad and down to Paramaribo, and immediately made ready to send ocean sweepers down. That is an awfully large area of ocean. From the fouling growth it was possible to determine that they had come from the west coast of Africa, and had come across in the south equatorial stream. Thereafter they were taken. But if we had gone out, trying aimlessly to locate those fields, a great deal of money and time would have been wasted.

It is this sort of thing that the laboratories, able to do basic research and located along the coast, can render service in, a very important service I feel, in the military, as well as their basic studies.

The CHAIRMAN. Doctor, let's take Rhode Island, a small State geographically. This is not a problem actually of the State of Rhode Island. This is almost the whole eastern seaboard problem when you talk of these things.

Dr. FISH. Yes. I am not attempting to speak for my own laboratory.

The CHAIRMAN. I know. I just point that out.

Dr. FISH. I plead the case of the small university laboratories.

The CHAIRMAN. Wherever they are.

Dr. FISH. That is correct.

Coastal university laboratories, if adequately equipped with permanent research staffs and facilities could greatly augment Federal fishery efforts to increase the harvest from the sea.

Except for a few species like the oyster, our control over the productivity of the sea is hardly greater than that of primitive man over the land. When he exhausted the game in any area he had to move elsewhere and today our fishermen must do the same or cease operations until the fishing grounds restore themselves. Even if we could conserve the existing stocks of food species, the supply would become progressively inadequate with the increase in human population, particularly in such areas as Narragansett and Chesapeake Bays. The status of the fisherman will need to be changed from that of a hunter to that of a farmer participating in the production of the crops which he harvests. Each coastal area has its special environmental problems which can best be handled by local marine laboratories.

The CHAIRMAN. That is a very fine statement, Dr. Fish. I appreciate your coming.

Senator SCOTT. May I ask this one question: Is your laboratory also interested in researching the diseases such as that with which the oysterbeds were afflicted so recently, and still may be, for all I know? Do you go into that?

Dr. FISH. We do not at this time have pathological studies. We have a bacteriological program which covers antibiotics on the role of marine bacteria in the sea on productivity. Dr. Seiburth's work was mentioned. That is as far as we have gone.

We have not been able to include the diseases or pollution aspects. We have a three-point program of basic research and a graduated curriculum which we are attempting to develop to meet the needs of oceanography. At the present time we have just approved the creation of the laboratory as a graduate school of oceanography. Our resource research is done at the State laboratory?

Sentor SCOTT. Who is pursuing, if anyone, the disease and pollution aspect such as that which afflicted the oysterbeds?

Dr. FISH. I believe the Federal Fish and Wildlife Service has a section concerned with that.

Senator SCOTT. That disease cost tremendous financial loss, as well as increasing cost to the consumer.

Dr. FISH. That is very true.

The CHAIRMAN. Thank you, Doctor.

Dr. FISH. Thank you, sir.

(Biographical sketch follows.)

CHARLES JOHN FISH

Address: Narragansett Marine Laboratory, University of Rhode Island, Kingston, R.I.

Born: Fall River, Mass., May 13, 1899, married, 1923; child, 1.

Major field of interest: Biological oceanography.

Degrees: Ph. B., Brown 1921; SC. M., 1922; Ph. D. 1923.

Professional career: Aquatic biologist, U.S. Bureau of Fisheries, 1922–27; director, Buffalo Museum of Science, 1927–34 (on leave 1931–33); executive secretary and senior scientist, International Passamaquoddy Fisheries Commission, 1931–33; assistant professor of zoology, Rhode Island State College, 1934–35; associate professor, in charge of department of zoology, 1935–36; professor, in charge of Department of Zoology and director, Narragansett Marine Laboratory, 1936–46; in charge Pacific oceanic biology project, Woods Hole Oceanographic

Institution, 1946–48; director, Narragansett Marine Laboratory and professor of marine biology, University of Rhode Island, 1948. U.S. Navy, Mine Warfare Operational Research Group, 1942–46. Captain, U.S.N.R. (Ret.), 1960.

Awards: James Manning Scholar, Brown University, 1921; Morgan Edwards research fellow, 1921–22; Secretary of Navy Commendation Ribbon, 1945; Legion of Merit, 1946.

Member: Amrican Society of Limnology and Oceanography; fellow, American Association for the Advancement of Science; Officier d'Academie, Republic of France; Bermuda Biological Station, Atlantic Fishery Biologists; Phi Beta Kappa; Sigma Xi; Phi Sigma; Phi Kappa Phi.

Scientific contributions in boreo-arctic, temperate and subtropical biological oceanography; Great Lakes limnology; military oceanography.

The CHAIRMAN. Dr. Ewing, director of the Lamont Geological Observatory, Columbia University. We are glad to hear from you, doctor.

STATEMENT OF DR. MAURICE EWING, DIRECTOR, LAMONT, GEOLOGICAL OBSERVATORY, COLUMBIA UNIVERSITY, PALISADES, N.Y.

Dr. EWING. Thank you, Senator. I am very grateful for the privilege of appearing here.

I am Maurice Ewing, a member of the National Academy of Sciences' Committee on Oceanography, Higgins professor of geology in Columbia University, and director of Columbia's Lamont Geological Observatory.

Marine research has been one of my principal fields of activity since 1935, and during the past 20 years I have averaged over 3 months per year at sea in charge of the work on a research vessel, and I still maintain that average. I have participated in the planning and execution of the majority of Lamont's research programs, in the design and construction of much of our equipment, in the founding of our laboratory, and in the development of its staff. We have built this institution from nothing during the period when Government support of academic research in the marine sciences has been developed from a very modest beginning to its present volume. We have seen the problems of Federal support of marine research from their infancy. Our research group has been built largely on the basis of Federal support.

The most severe limitations on this development has been the difficulty of obtaining laboratories and shore facilities, and in establishing faculty positions.

We have been able to overcome some of these obstacles and grow to our present condition through extremely fine cooperation of the Office of Naval Research, the National Science Foundation, and several private foundations.

My formal training is in physics and mathematics. My research has been about half in oceanography—broadly defined—and about half in other branches of geophysics.

1. Perhaps it is because my scientific interests and activities extend beyond the broadest definitions of oceanography that I appraise the rank of the marine sciences, in the hierarchy of all of the sciences, as a rather modest one. And here I speak with the knowledge that you, Senator, know a lot more about the National Science Foundation than I do, but I give you my opinion for what it is worth.

The CHAIRMAN. I don't know that my knowledge is any greater. I have been exposed a little bit longer.

Dr. EWING. Despite a firm belief that Federal support of marine research should be increased, I think that within the structure of the National Science Foundation the rank of program, perhaps one in each of the two appropriate divisions, would be more appropriate than the rank of division. The intention of this suggestion is decidedly not to decrease the role of the NSF in the national oceanographic program, but rather to place the marine sciences in proper perspective within the whole structure of American science.

The CHAIRMAN. Doctor, I think that is what we are trying to do. We may have some differences as to just how to do it, but it is a detail I am sure that can be worked out.

What you say there is exactly what we are all trying to do.

Dr. EWING. Without doubt, NSF, even with its arrangement for marine sciences, has been an extremely effective agency for advancing the national effort in oceanography during the past few years.

2. The proposed divisional committee which "shall include among its membership a representative from the Office of Naval Research, the Hydrographic Office, the Coast and Geodetic Survey, the Bureau of Commercial Fisheries, the Atomic Energy Commission, the U.S. Coast Guard, the Public Health Service, the U.S. Weather Bureau, the Beach Erosion Board of the U.S. Corps of Engineers, and at least six scientists selected on a basis of competence from universities and other non-Federal institutions and designated by the National Academy of Sciences and National Research Council to serve on this committee," is entirely different in character than the divisional committees of the three existing divisions. In my opinion, a group, two-thirds of which consists of appointees of the Government bureaus—some of which have only minor and recent contacts with scientific research of any kind—would be unsuitable to represent and control one of the four major divisions of American science. It is only necessary to compare the proposed divisional committee with the existing ones to recognize the difference in concept involved.

Even if marine sciences should be established at the rank of a program, the proposed committee would, in my opinion, be inappropriate. I believe that the divisional committee should be made up of outstanding scientists in the field, as are the parallel committees. Certainly this would include scientists from Government agencies, but they should be chosen on the basis of individual achievement as scientists and not as spokesmen for the agencies which they represent.

If I could add to what I have written here, I would like to say that the Interagency Coordinating Committee has been an extremely effective organization. If I have understood the draft of the bill correctly, you have tried to preserve that function and add to it as you mentioned in the bill.

The CHAIRMAN. I think that is a very fair analysis of it. There has been no intention to degrade or downgrade the Interagency Committee because this has been the one group which has done the job in the interim, and a good job. There is no argument about that.

Dr. EWING. 3. In several parts of the bill, research costs and instruments are listed separately, and the cost for the instruments is far too high with respect to the other research costs. I have continuously and consistently supported the idea that useful instruments are likely to originate in the minds of the potential users and nowhere else. If industry or the "systems and instrument men" are called in too soon, or are given control of instrumentation budgets, waste will result. Therefore, I propose that the sums labeled "instruments" be combined with those labeled "research" and controlled by the research scientists. The man who wants to create an instrument just to create an instrument—assuming or hoping that someone else will adapt that instrument for some useful purpose—is usually harmful. An instrument or instrument system for research is only useful if it provides information that is wanted, and provides it as conveniently as possible. It is the people who want that information who should either create the instruments or decide on their main operating characteristics and contract their construction out to industry.

The CHAIRMAN. I think, Doctor, that is a good suggestion for the bill. Of course when you say I have had more experience in one field, you have had much more in this. That is a good suggestion. In other words these are things which don't come up in production.

Dr. EWING. The following points do not relate directly to Senator Magnuson's bill, but to general questions of Federal support of scientific research in the United States—particularly research in the marine sciences—and I will speak about only the part of it of which I have firsthand knowledge; namely, geophysical and geological investigations in the deep oceans. However, many of the conclusions apply to many other branches of scientific research.

(*a*) Support should go principally to individuals or to groups built around a core or team of individuals who have shown that they have productivity, viability, and a marked ability to work together. When this principle is ignored and massive support is poured in to create a big research organization with the idea of filling it in with the available people, the institution usually fails or requires a number of years before it becomes really creative and productive. In the meantime, it has vast crippling and destructive effects, for by overshadowing the efforts of smaller creative groups it can spoil their morale, wreck their budgets, rob them of personnel, and effectively disrupt the organization. That would be along the lines which Roger Revelle mentioned of opposing the creation of a big structure that it would hope would develop into a national oceanographic institution.

The CHAIRMAN. And this is the sort of thing that, whatever kind of group or agency or coordinating activity is set up, this is the sort of decisions which they would have to make. This is one Congress can't make.

Dr. EWING. It might be persuaded to try to make it. That is what I am afraid of.

The CHAIRMAN. I hope that we don't try to become oceanographers; although I might qualify for admission.

Dr. EWING. In most fields of scientific research today there are two principal requirements for productivity: an expensive, carefully created complex of equipment and facilities, and a well-integrated team of talented, cooperative scientists who like to work with each other. Such units must be grown. A research institution cannot simply be assembled by effective, adequately financed management. No matter how excellent the management, how good the intentions, how great the need, or how adequate the budget, the fact is that for achievement in any branch of science, the basic need is for creative, scholarly individuals. It is around such men that programs should be built. These men and groups should be supported sufficiently well so that they are not frustrated in their efforts; but are allowed to build their programs up to the optimum size. We should aim for earned growth rather than for creating full-blown large organizations which will need many years of experience before they can function as an effective team.

(*b*) In oceanwide marine research the major institutions are inevitably fashioned around their ship facilities, and the size of the institution and its total budget depend very largely on how many big ships they undertake to operate. From this viewpoint the cost of the ships and their initial equipment are not really the major factor. The starting point for planning is the operating costs of the ships. From statistics recently issued, the operating costs of an oceangoing research ship, of the kind now in use or in prospect in this country, varies from a quarter-million to a million dollars per year. This is simply the price of operating the ship, not of doing the science on it. Under present circumstances the shipboard and shore-based programs which the ship can support will cost at least five times the operating costs of the ship. A scientific program less than about five times the operating costs of the ship operations will, in general, not make full use of the capabilities of the ship. The capital investment is the cost of the ship and the approximately equal cost of the shore-based establishment, but these capital investments should not be made unless one is prepared to budget for the continuing annual cost of a quarter-million to a million dollars for ship operations, and approximately five times that for scientific program. The ship is the unit about which a program in oceanography should be built, and any institution should have its growth in large steps as ships are added.

(*c*) The major part of the research effort should be situated in academic institutions or in institutions or bureaus which have the broad interest and intellectual vigor which characterize the finest academic institutions. It is very rarely that one finds such characteristics dominant in a Government bureau, and indeed, in general they are probably not the most desirable characteristics for a Government bureau. But they are essential to creative basic research. We must keep clearly in mind the need for pursuing both basic research and the very important surveys and applications; but let us not deceive ourselves that we are funding one when we are funding the other.

(*d*) Continuity or stability of support and the creation of far more career positions are essential if the marine sciences are to be able to attract, train, and hold a fair share of the top grades of scientists. It appears that cooperation of Government, industry, foundations, and universities will be required.

(*e*) Political influences in the allocation of Government support of basic research must be reduced. Clearly an increasing percentage of the support will come from Government. A difficult course must be steered between the hazards of allocating more of the research to Government laboratories on the one hand, or the demand to have one of each in each of the 50 States on the other hand. The problems of wisely administering these great sums is sufficiently difficult if only scientific considerations must be heeded.

The CHAIRMAN. Thank you, Doctor. I appreciate your coming.

Dr. EWING. Thank you, Mr. Chairman.

The CHAIRMAN. Dr. Schaefer, of the Inter-American Tropical Tuna Commission, La Jolla, Calif.

STATEMENT OF DR. MILNER B. SCHAEFER, INTER-AMERICAN TROPICAL TUNA COMMISSION, SAN DIEGO, CALIF.

Dr. SCHAEFER. My name is Milner B. Schaefer. I am Director of Investigations of the Inter-American Tropical Tuna Commission. I am also a research associate and lecturer of the Scripps Institution of Oceanography at the University of California.

I very much appreciate this opportunity to appear again before this committee in order to speak about certain parts of S. 901.

As you know, I have been working, together with my colleagues on the Committee on Oceanography of the National Academy of Sciences, for some years on the formulation of a national oceanographic program which would provide for an adequate coordinated effort, by the many governmental agencies involved, to bring the marine sciences in the United States to a level of accomplishment corresponding to the Nation's needs. I have been especially concerned with those aspects of the program which deal with the resources of the sea.

The past and present efforts of the United States directed toward the study of the resources of the sea, which provide the basis of fisheries and other extractive industries of great importance to our citizens, are simply inadequate to meet the growing needs of our country and the world. The harvest of the sea fisheries is growing rapidly, and newly exploited fish stocks are adding to that harvest year by year. What were formally small, coastal operations have expanded to cover most of the oceans, and the products are being sold on highly competitive international markets. The United States is not, except in a very few instances, participating to any appreciable degree in this expansion, the U.S. share of the world's seafish harvest having remained almost static while the fishermen of other nations are rapidly expanding their operations.

For example, in the North Pacific and Bering Sea, the rich stocks of bottom fish have, during the last few years, been brought under heavy exploitation by Russian and Japanese fleets. The rich fisheries off the West Coast of Africa were explored a few years ago by Russian research vessels and Japanese research vessels, and are now being rapidly developed by fishermen of these nations, and some 10 others, including, fortunately some from the United States, as Dr. Chapman described to you yesterday.

The U.S. participation here, however, received little aid from research vessels of our Government, the exploratory research having been done mostly by private enterprise with assistance from the Government of Ghana.

The Committee on Oceanography's report "Oceanography 1960–70," in the chapter on "Ocean Resources" and elsewhere, outlined the augmented program of research which, in our opinion, is the minimum requirement to meet the Nation's need in this field. It called for a large increase in long-term basic research, for replacement of inadequate and obsolete research vessels and the construction of additional ones, for comprehensive oceanographic and biological surveys, for the construction and use of unmanned buoys to measure the season-to-season and year-to-year changes in the ocean which affect the fisheries, for research on behavior of fishes, for laboratory studies to elucidate some of the important causes of fluctuations in the fish stocks, for the establishment of a National Oceanographic Data Center, and for vigorous efforts to increase the trained manpower devoted to oceanographic research.

We were very pleased that all of these things were provided for in the Magunson bill of the last Congress, and were disappointed that its passage was not completed. We would hope that the new bill, S. 901, which again provides for these essential studies would receive favorable action.

It is to be noted that, through the efforts of the Interagency Committee on Oceanography working under the Federal Council, and the efforts of individual departments, some of the recommendations have been implemented, at least in part. We are particularly pleased to note that a National Oceanographic Data Center has been established with joint support from several departments. Little progress has, however, been made on other items of at least equal importance.

Despite strong recommendations of the Committee on Oceanography, and of a special Committee of the American Society of Limnology and Oceanography, regarding the critical need for funds to increase the education of oceanographers, practically no progress has been made in this direction.

The Committee on Oceanography recommended construction, over a 10-year period, of 14 new ships for research on marine resources, 7 to replace existing overage and obsolete craft. Funds have been appropriated to construct one new vessel, meanwhile three have been removed from the service of the Bureau of Fisheries, and one other is being operated with a short crew and lack of adequate maintenance. It would appear that we are losing ground.

The CHAIRMAN. Dr. Revelle testified that the recommendations of the Committee were taken not completely literally, but sort of as guidelines. Surely in ship construction this is literally a minimum program.

Dr. SCHAEFER. The minimum guideline should be more, not less. We should be gaining instead of falling behind.

Very little attention has been given to the development of unmanned instrument buoys, and practically none to the development of mesoscaphs and other new instrumentation for resources research. No action has been taken on the construction of laboratory facilities for the study of fish behavior or for the critically important studies of the survival of young stages of marine organisms. Provisions of personnel to commence biological surveys of the oceans aboard vessels making cruises for other purposes has been negligible.

It is my firm opinion that the required program in resources research is not likely to be activated without further stimulation, and I am very pleased to note that S. 901 authorizes appropriations to the Department of Interior and other agencies for these purposes, and also provides a means for proper coordination of the work of different agencies through a new Division of Marine Sciences of the National Science Foundation, having representation from other agencies concerned.

We are also pleased to note that S. 901 contains authorization for the Coast Guard to participate in the oceanographic research program.

The CHAIRMAN. As I remember we didn't have that in last year's bill.

Dr. SCHAEFER. I believe this is correct. It turns out that the Coast Guard has the capability of contributing significantly to ocean research. Indeed, during the past year some important physical and biological data have already been collected from weather ships and picket vessels operating off the west coast. The picket vessels, in particular, offer a marvelous opportunity for a valuable study of time-series of changes in the physical, chemical, and biological properties of the eastern Pacific off our coast, at very little additional cost. The Eastern Pacific Oceanic Conference, which is an informal association of oceanographers working in this region, and had the privilege of having Mr. Markel, of your staff, attend our last meeting, has drawn up plans and budget estimates for a program of observations to be carried out by scientists aboard these vessels and for the analysis of the resulting data.

It is our impression that the officers in charge of these craft, and their supervisors, as well as scientists from several governmental and university laboratories are enthusiastic about this program, and it is hoped that it may be implemented in the near future. This is but one example of how the Coast Guard can, and should, be integrated into the national oceanographic program.

The CHAIRMAN. Thank you, Milner. I appreciate that statement.

Is Mr. Snodgrass here? Mr. Snodgrass is a member of the Special Committee on Oceanographic Instrumentation, Scripps Institution of Oceanography, La Jolla, Calif.

We will be glad to hear from you.

STATEMENT OF JAMES M, SNODGRASS, HEAD, SPECIAL DEVELOPMENTS, SCRIPPS INSTITUTION OF OCEANOGRAPHY, UNIVERSITY OF CALIFORNIA, LA JOLLA, CALIF.

Mr. SNODGRASS. Mr. Chairman, members of the committee, my name is James M. Snodgrass, research engineer and head of special developments at the Scripps Institute of Oceanography, University of California, at La Jolla.

Among my functions at Scripps is assisting members of the staff and students in instrument problems.

The CHAIRMAN. Doctor, you have quite a long statement here. Are you reading from some notes that highlight it?

Mr. SNODGRASS. Yes.

The CHAIRMAN. We will put your statement in the record in full, and we will keep the photographs for the files, for the rest of the committee. Are you going to highlight your formal statement?

Mr. SNODGRASS. This is somewhat in addition to that.

The CHAIRMAN. Do you want to highlight the statement? Go right ahead in your own way.

Mr. SNODGRASS. Would you prefer that I did not read the report as it is here?

The CHAIRMAN. I think because we are running close to noon here, we could put your statement in the record in full and you could highlight the statement. It would save us a little time.

Mr. SNODGRASS. I think the major problems with which I am concerned basically support the statements made by Dr. Ewing. Some of them in regard to the fact that adequate shop facilities must exist in close relationship to the research oceanographer because the shops, after all, are the ways which he has of translating his ideas in the immediate action from the standpoint of instruments.

Instrument development and construction: It is imperative that adequate shop facilities, both electronic and machine, be available to research oceanographers. It is through the shop facilities that it is possible for the research oceanographer to have his ideas for research instruments translated into experimental hardware with a minimum of delay. By the very nature of research programs relating to oceanography at the present time, it is an extremely rare research program that does not require the devising of original or specialized instrumentation.

Perhaps in no other field of science is it necessary to have such close cooperation between the electronics engineer and the precision machinist as in the field of oceanographic instrumentation. This means that instrument construction should have the machine shops and the electronics shops closely integrated; both from the physical and personnel standpoints.

It is safe to say that none of the research institutions have anywhere near adequate shop facilities. In fact, the lack is actually acute. The problem is essentially a threefold one, and stems largely from lack of funds. First, there is the lack of space, equipment, and personnel. Some of the committee members may well have seen photographs taken at the Scripps Institution of Oceanography showing the tremendous overcrowding and unsatisfactory facilities. It is admitted that the situation at the Scripps Institution of Oceanography may be one of the worst, but it is not an extreme example of situations which exist at other institutions. With severely limited space and personnel, it is impossible to undertake more than a very limited number of research and development projects.

Ship support facilities: Adequate ship support facilities are imperative and this is clearly stated repeatedly in various sections of S. 901. In order to keep down ship operating costs and to make the best use of the scientific personnel time, it is necessary that the oceanographic research vessels have a short turnaround time. Further, the nature of oceanographic research requires that the research vessels undergo an almost constant refitting when in port and the bulk of this refitting is of a highly specialized nature which is closely integrated with the particular research program at hand.

In spite of quite inadequate facilities and the necessity for using the U.S. Navy Electronics Laboratory docks in San Diego Bay, the Scripps Institution of Oceanography has been able to obtain an average of 238½ days at sea per year over the last 5 years with each of its larger ships. In fact, the research ships are being worked very hard.

Field operations and staging areas in the immediate vicinity of the ships is imperative. This would include facilities for storage, some of the areas covered and uncovered, handling facilities for heavy equipment, such as cranes, forklifts, and so forth. Maintenance shops should also be located close to the ship docks. The field operations area should also include suitable dock space, crane facilities, and small boats to make practical shore testing of research equipment. Adequate shore test facilities of this sort would often save substantial amounts of ship time which would otherwise be necessary for testing purposes.

Need for long-range programs: One of the major problems which confronts all of the oceanographic research institutions at the present time is the fact that most research projects are funded over a short period of time. Unfortunately, there are usually delays for one purpose or another, which results in the fact that purchases and instrument construction cannot begin when desired. At the Scripps Institution of Oceanography the effect of the short-term support has been to make nearly all of the research projects assume the nature of "crash" programs. This often means, as far as instrumentation for a given research program is concerned, that it must be tailored more often to the time available than to the requirements of the project. Frequently the limited time means that no new devices will be produced simply because there is simply not enough time, or that the research leader prefers not to take any chances and to use older equipment, which though not desirable will nevertheless function with a minimum expenditure of shop time. This means, of course, that research is basically handicapped and progress is severely retarded.

From the support shop standpoint these "crash" programs have the effect of producing severe excessive peak demands which may require inordinate amounts of overtime which besides being tremendously wasteful does not always by any means result in the construction of satisfactory instruments.

It is sincerely hoped that allocation of oceanographic research funds may be made available over a substantially longer time base by the funding agencies.

Communications: Communications, in one form or another, is inextricably linked with oceanographic research and oceanographically oriented research projects. Unfortunately, it is only within comparatively recent time that the oceanographers have begun to become aware of their needs. The oceanographers' needs involve truly worldwide requirements.

For convenience we may classify our communications requirements as follows: ship to shore, ship to ship, oceanographic instrument buoy to shore, oceanographic instrument buoy to ship, shore to oceanographic instrument buoy, and ship to oceanographic instrument buoy. Even relatively simple oceanographic research programs require inquire increasingly better communications. Officially, the oceanographers have very poor frequency assignments which result in limited range and unreliable communications. Often necessary research requiring radio communications is accomplished under somewhat questionable and perhaps extra legal ways. The Scripps Institutoin of Oceanography has been indeed fortunate, due to the cooperation obtained from the U.S. Fish and Wildlife Service, which has made available some of their frequency assignments by, in effect, setting up a radio station which they control, but operated with funds from the Scripps Institution of Oceanography. Without this fortuitous assistance much of the present farflung research of the Scripps Institution of Oceanography would be severely restricted or curtailed. Perhaps it should be pointed out that, due to the immediacy of the communications requirements, it has not been proven possible to operate through commercial channels.

I should also add at this point that in view of the Mohole project with which you are familiar, which is such an exciting project and of such great scientific importance, this would be impossible even at the present stage without this gratuitous assistance of the radio communications which we are now able to render.

The CHAIRMAN. Your problem is before the Federal Communications Commission there.

Mr. SNODGRASS. This is perhaps true, I agree. It happens, however, that the problems of the oceanographer and some of the others which fit into the marine sciences I think need to go as a whole, perhaps.

The CHAIRMAN. Do you operate on FM?

Mr. SNODGRASS. We have very little FM work at present. We would like to have it but we do not have the assignments for it.

The CHAIRMAN. Aren't there a lot of FM frequencies available?

Mr. SNODGRASS. I think when it comes to that, F.M. at present, of course, you have to remember is essentially high frequency and is line-of-sight communications. This does not operate for the farflung transmission problems.

The CHAIRMAN. You have to be on AM?

Mr. SNODGRASS. At present this is true. I think this is just the nature of the assignments and the bands that are used.

The CHAIRMAN. Has anybody applied to the FCC and been turned down?

Mr. SNODGRASS. I think that there are others here who are better able to speak to this than myself. I think that has been a running problem almost for years in obtaining operating frequencies.

The CHAIRMAN. There is only so much to the spectrum, I understand that.

Mr. SNODGRASS. This is correct.

The CHAIRMAN. And the engineering problems of allowing frequencies too close together or where they interfere is a problem with the FCC. The FCC appears before this committee frequently, and they have enough FM channels to handle this matter.

Mr. SNODGRASS. I think this is something, as I mention a little later, that can be taken care of.

The CHAIRMAN. That is a matter that we can take up with the FCC.

Mr. SNODGRASS. Expanding oceanographic programs are planned which will require the use of instrumented buoys and the transmission of information by means of radio telemetering both to ship- and shore-based stations. It appears to be almost impossible to plan anything like a serious program involving the use of remote buoys or ocean stations if we must count on presently available frequencies in the electromagnetic communications spectrum. The difficulties are complicated by the fact that available frequencies are already largely allocated and are used almost completely by the military, commercial, and amateur interests. There do not appear to be any suitable frequencies for extensive reliable communications available to the oceanographic-oriented research programs

The CHAIRMAN. I think you will find that they are available. Whether you get them or not is another story.

Mr. SNODGRASS. That, sir, is true.

Anticipating the general problems of the oceanographer, the Office of Naval Research sponsored a study contract on oceanographic telemetry (Contract Nonr–3062(00)) with the Convair Division of the General Dynamics Corp. The first phase of the study has been completed, and a very excellent report has been submitted to ONR. One of the purposes behind the study contract was to investigate various factors involved in telemetering data from remote oceanographic instrument buoys to shore-based facilities. The factors which must be considered in this operation are tremendously involved and complicated. Some of the factors involve the behavior of specific radio frequencies in regard to radio propagation characteristics, such as ship distances, seasonal variations of noise with respect to latitude, solar-induced radio propagation anomalies, power requirements, frequency band widths, and so forth. All of these variables have not been organized and collected together in the report submitted to ONR by Convair.

It appears that long-range communication may not be considered reliable using whatever frequencies may be available between a shore-based receiving station and remote buoy or ocean station. This is assuming that dependable communication is required and that data be transmitted without objectionable error. It is quite true that one may obtain occasionally, and even for a limited period, transmission which might be considered acceptable. The difficulty, however, is that such conditions cannot be counted upon if reliable transmission is required. It is therefore necessary to seek modifications of the system whereby reliable communications may be established.

The CHAIRMAN. This may be a naive question. What do you find out from a buoy?

Mr. SNODGRASS. This is something that oceanographers, I think, have some very good ideas about. The buoys have an advantage of the anchored buoys staying on station.

The CHAIRMAN. You get recordings from the instrumentation aboard?

Mr. SNODGRASS. Yes, sir.

The CHAIRMAN. I suppose the simplest thing would be wave action?

Mr. SNODGRASS. This can be done also.

The CHAIRMAN. Go ahead.

Mr. SNODGRASS. Perhaps the most available method at present to begin to solve the buoy communication problem, and evolve a method which could be put into effect with existing technical facilities is the use of high-flying aircraft to serve as an interrogation platform for communicating with floating buoys, and so forth. This would permit the use of relatively low-power radio transmitters in the buoys and a relatively simple information storage system. The high-flying plane would transmit a suitable coded interrogation pulse which would insure the response of the desired buoy. Since the airplane would be carrying a suitable recording system, such as magnetic tape, the information transmitted by the buoy could be recorded as desired.

In this system it would be planned to have the data processed at the conclusion of the flight. Difficulties with this system are not to be minimized since it requires the availability of suitable high-flying long-range aircraft, as well as the necessary operating bases. However, it would be possible to carry out some fairly extensive programs with existing bases and aircraft. It should also be pointed out here that suitable radio frequency assignments must be made if communications of this type are to be carried out.

Here I should like to make a proposal that I hope will be looked at reasonably seriously. I think we might suggest here that a very fine use for the U–2's is in the matter of using them for high-altitude interrogation work of this type because of their design.

The CHAIRMAN. If they will just keep on course, we will be in good shape.

Mr. SNODGRASS. These were designed for scientific work, and I think in a progressive country, if we are going to take the lead, we need such aggressive and imaginative arrangements of this sort.

Another and most promising system for long-term operation is to be found in the various types of communications satellites. First, the active satellites, which are planned on being programed for orbits between 5,000 and 6,000 miles, will undoubtedly require powers that are not readily available to small floating buoys and floating instrument stations. However, these satellites can be counted upon for communicating between ships and shore bases using stabilized dish-type antennas. It would thus be possible to transmit a very large amount of data with high reliability from ship to shore and vice versa using the satellite system. This would mean that it would be possible to send data directly ashore for data analysis as desired. The active satellites which are referred to for this type of data relaying operate in real time.

Another type of satellite known as the Courier type is perhaps the most adaptable under the present basis of operation. The Courier type of satellite does not retransmit radio signals in real time, but involves a delay system. The Courier satellite is planned on being programed to a much lower orbit, namely the range from 300 to 400 miles. Since it is much lower, it will require a great deal less power to effect reliable communication between buoy and satellite. At present the Courier type of satellite is designed to record information received via radio and play it back on proper interrogation from the ground-based station. It is considered practical to program the Courier type of satellite to interrogate buoys as it passes over various portions of the ocean and then to playback or reproduce the data obtained from the buoy when it passes over a suitable land-based station. The land-based station would be enabled to keep a longer contact with the satellite since it would have a much superior antenna system than that possessed by the floating station.

A most significant problem presently exists with the proposed use of any of the satellites and this is the fact that there are presently tremendous demands upon the electromagnetic communications spectrum that is expected to be available to the satellite systems, and unless the research groups interested in obtaining ocean data make a very strenuous effort to obtain proper frequency allocations or time allocations on the communications types of satellites, it is quite certain that none will be available when needed at some future date. It is almost impossible to overemphasive the amount of pressure being brought to bear to obtain communications frequencies in the satellite programs. Since the groups interested in collecting data from the ocean are not presently represented in any way on the committees and boards making such studies, it is imperative that some steps be taken along this line as soon as possible.

There is another possible system, which has recently come to my attention that may offer possibilities for reliable communication with remote buoy stations. This is a technique that has been explored extensively by the Canadian Defense Research Establishment. The substance of the method developed involves the use of an interrogation technique between the shore-based station and the remote buoy. In this technique the buoy is equipped with a transponder system which is interrogated by means of short pulses on a short duty cycle transmitted repetitively by the shore-based station. When the radio propagation conditions are suitable, and the interrogation pulse is enabled to reach the buoy, the buoy transponder sends out a pulse which is received by the shore station. This signifies that the communications path is for the time being open between the two stations. The shore-based station then sends a coded request to the buoy to transmit its stored information. When this cycle is completed, the shore-based station then seeks to interrogate another buoy, and so forth.

This particular system is based upon the fact that when a given transmission channel becomes open between two stations it may be expected to remain open for a period of from 4 to 5 minutes. If suitable recording and memory systems are on board the buoy, it is quite practical to count on interrogating the buoy at some time during a given 25-hour period. However, it is apparent that one cannot establish over a long period of time precisely when it will be possible to interrogate the buoy, thus the memory system must take such variables into account.

There is an additional alternative to the above-outlined system, which is recommended by the Canadian defense research group, and that is to have available a selection of a wide range of radiofrequencies for such a communication system and that the shore-based interrogation system transmit an interrogation pulse in sequence through the different assigned frequency bands. This means, of course, that the remote buoy must have a somewhat more sophisticated receiving system; that is, one which can listen simultaneously on all of the expected frequency bands. However, if such a system is used, the assurance of being able to effect communication with the remote station when desired is tremendously improved.

This latter method is the method which apparently receives the most favorable recommendation by the Canadian group. One point should be made clear, however, if such a system were used it would require a considerable change in the basis of the present assignment of radio frequencies to a given activity, since this involves the use of a wide range of frequencies and this is not now the common practice as far as licensing by the FCC is concerned; thus certain changes would have to be sought in this regard. One might well ask questions as to whether the type of interrogating and transmitting system might not be expected to interfere seriously with other types of radio communications. According to the Canadian authorities this is not the case because the pulses are extremely short in duration and only appear as a type of noise that is not unusual in radio communications, and, therefore, does not seriously interfere with other transmitters.

Due to the tremendously complex nature of the communications problems involved, we need immediate, competent, high-level engineering assistance, probably in the form of a consulting engineering firm, to assist the oceanographers by taking examples of realistic buoy programs and working out the frequency requirements with the assistance of the Convair-ONR report. Until this is done, we cannot realistically make requests for radio frequency assignments.

Since the oceanographers communication problems extend well beyond the continental limits of the United States, it is apparent that international relationships are almost certainly involved. This would be true whether high flying aircraft or satellites are used in the solution of the communication problems. It is felt that immediate steps should be taken to get the requirements for oceanographic oriented research programs set forth before the proper Federal agencies and commissions. The very excellent staff report prepared for the Committee on Aeronautical and Space Sciences of the U.S. Senate entitled "Policy Planning for Space Telecommunications," dated December 4, 1960, contains many pertinent references to our problem. Following is a quotation from the letter of transmittal of the above document:

> Because space telecommunications, although representing a fresh technology, must be compatible with existing national and international communications systems, the report indicates that planning for the future must be consonant with overall U.S. communications policies. This matter becomes of particular importance to the Congress because of the large number of agencies now having cognizance or jurisdiction over various aspects of either communications or space research and operations and of the unusual degree of coordination thus involved.

We must evidently take the problem of ultimate congestion in the electromagnetic communications spectrum of the satellites seriously, as may be seen from another reference to the above document by the Office of the Director of Defense Research and Engineering, page 152, in answer to question 6:

> However, we agree that, despite our best efforts to make most effective use of the spectrum, one can conceive of growth in the use of space which sometime in the future may result in "spectrum crowding." The severity of this problem will depend not only upon the growth of space operations internationally but to an important degree upon technological accomplishments permitting an extension of the usable spectrum and making more effective use of available bandwidth.

Quite possibly, at the risk of being premature, since it is now understood that the U.S. Army has cognizance of the communications types of satellites, it may be well to add to section 15 of S. 901 a request to assist oceanographically oriented agencies and programs in their communications requirements involving the satellites.

It is hoped that international cooperation may be obtained in the assistance of radio frequency assignments for the oceanographic research programs. This is doubly necessary since oceanography like other sciences such as astronomy and meteorology is basically international in nature.

The CHAIRMAN. We have international agreements on frequencies I think with practically every country in the world; on allocations. I think what you point out is very important. I just don't know who will make the application unless it be some specific institution.

Mr. SNODGRASS. I think this is the problem that we are facing in the matter of how we go about these, because I think that a specific institution probably only represents a small part, and this is where we do need a form of coordination.

The CHAIRMAN. You would have to have an application in for a frequency, and it would have to come from somewhere.

Mr. SNODGRASS. That is correct.

The CHAIRMAN. I might suggest to you that the military have usurped about one-third of the spectrum, and they never will tell me what they are using it for.

If I suggest that they are not using it, they immediately start a research project on one of the frequencies; they are studying it. Maybe we might get in on their act.

Mr. SNODGRASS. I think that would be a good way if we could manage it. I think the isolated institution has a particularly difficult problem because in the view of the tremendous organizations which are after frequency requirements they are simply too small. They need a larger collective voice in some way. I do not know how to go about it, but I know that this is something we need to look at hard.

Research instrumentation: In view of the critical need of the marine sciences for radio frequency assignments for use in operations, data transmission, both terrestrial and via satellite relay, I would like to respectfully suggest that the communications portion of S. 901 be substantially strengthened.

The research oceanographer requires a constantly increasing number of new instruments. At present it is felt that this need can, by and large, be more expeditiously met by having research support facilities as an integral part of the oceanographic research complex. This, however, should not be construed as excluding in any way assistance from outside organizations which may be pertinent to the development of the research tools. The research support facilities are in no wise meant to be production facilities, and it is certainly advisable to confine instrument development to the production of prototype instruments which are needed for the research programs. If additional units are required, they should be made by outside organizations.

Since new instrument development to supply the demands of the research programs requires much detailed and careful testing, it is strongly urged that suitable test facilities be available and located close to the development laboratories. This would have a major advantage, since, if carefully planned, the test facilities could serve the dual function of aiding in the development of instruments, and, at the same time, serve as experimental model tanks for research studies on such projects, for example, as ocean sediment motion and pressure effects. It would be expected that the test facility would consist of, but not be limited to, such things as tow tanks, high pressure test chambers, temperature controlled baths, and wave generating tanks. It is imperative that the hydraulic test facilities be located near the instrument development facilities, as this will materially improve results and save a large number of man-hours and production time.

Perhaps we should view oceanographic instruments in another perspective to better understand their true value and function. As you well know, modern instruments are often very expensive. Statements made as little as 2 years ago are much too low for many items. Design changes and new concepts both tend to increase costs. True, costs are increasing but fortunately fishery is increasing at a much faster rate. Just what do we mean by this? Suppose, for example, it takes 10 men's time to build a given instrument, but this instrument can do as a measuring instrument what it may well take 100 men to do. Lack of available manpower for an available expanding oceanographic program is one of our greatest problems. We can best support this manpower and the development of future leaders by giving them the best possible instruments.

A healthy and fundamentally sound oceanographic survey program will, by and large, come to depend upon the research laboratories and research instrument development facilities for prototype development of potential survey instruments.

Oceanographic research laboratories closely integrated with research support facilities tend to maintain a reservoir of information relating to techniques and methods useful in subsurface research. This fund of information is constantly increasing and should be readily available to outside organizations who have an obvious need to know. At present there is no officially recognized organization to whom outside organizations can turn what they feel the need of obtaining information on subsurface instrument techniques. Properly planned and implemented portions of the research support facilities could well serve this most important and critically needed function, which certainly has a direct bearing on national defense capability. That there is a need to know on the part of outside organizations is is apparent from the experience of at least two of the major oceanographic institutions, namely, Woods Hole and the Scripps Institution of Oceanography. In my own case, for a period now somewhat over 2 years, there has been an average of better than one personal contact per day seeking information. At the same time there have been an average of more than two long-distance telephone calls per day for the same purpose.

Oceanographic instrumentation in the modern sense may be considered as just getting underway. It is urgently recommended that the coordinating agency for oceanographic research consider at the earliest possible moment establishing certain desirable standards relating to telemetering and oceanographic data acquisition patterned along those presently in effect established by IRIG (instrument range instrument group) for use in aircraft and missile flight test and research programs. At present it is feasible to use certain portions of the IRIG recommendations in the oceanographic telemetering field. However, it is felt that the field is sufficiently large and unique, presenting special problems, as to justify the development of suitable standards which are more universally applicable. It is not considered that such standards would in any wise be restrictive, but rather would operate as the IRIG standards did in actually facilitating and improving the entire flight test and missile instrumentation programs. In fact, if we are to operate extensive survey programs, it is imperative that something of this type be done. The research instrumentation development would also profit very materially because this would serve as a reservoir of essential hardware and electronic components which would be already standardized and available, and would need only to be packaged with the specific new portion of the instrument development to have a completely satisfactorily operating instrument. This would have the very major effect of reducing the total time needed for developing a new instrument, plus insuring the fact that it would immediately be able to be used with an existing information and data processing system.

One of the major problems at present is that, due to the nature of funding of research projects, it is frequently impossible to develop for many years obviously desirable instruments. This is due to the fact that some of the desirable instruments, while being desirable for the particular project, cannot be considered critical, and, further, if they were available, they would be used on many other projects. However, no one research program is able to support the development if it involves any significant sum of money. A specific case in point involves what may be called a constant tension winch. This would require at the present an expenditure of something between $40,000 and $45,000, and this is substantially more than any current research programs could support as a developmental piece of equipment. However, it is considered of critical need as we move into newer and more precise oceanographic instrumentation. The fact that we do not have such a winch at the present makes it difficult to make winch recommendations for the new proposed series of oceanographic research and survey vessels.

Somewhat parallel with the above problem is the need for being able to occasionally test and evaluate, and in some rare cases build instruments which have been proposed or developed by outside groups. The difficulty at present is that often an instrument developed by an outside group may demonstrate what appear to be very useful characteristics, but the measurements which the instrument may make do not seem to appeal to antisubmarine warfare groups, for instance, simply because they do not understand the nature of the measurements, and would prefer to have it checked out by some oceanographic research group. Here again it is often impossible to find a research scientist who is willing to take the time to properly evaluate and test the instrument. A coordinating agency should be able to solve this type of problem.

Since it appears that at least for a long time in the future oceanographic oriented research will continue to be conducted by a fair number of different organizations and agencies, it should be obvious that coordination is imperative. I do not mean coordinate in the sense of control, but rather to assist in the major function of communication and exchange of information. There does not presently exist any mechanism to accomplish this highly desirable and essential function. Such coordination would certainly reduce often unnecessary experimentation and in the long run make major cost savings.

The CHAIRMAN. You do pose a problem. This is probably one which the Interagency Committee could discuss with the FCC, because it is a broad problem; maybe in the future there should be something set aside for this sort of thing.

Mr. Snodgrass. I don't know, but these photographs given me are for the committee. They are the Lamont Laboratory, showing similar problems.

The Chairman. We will keep them in the committee files for the committee.

Mr. Snodgrass. Thank you.

(Biographical sketch follows:)

James Marion Snodgrass

Address: Scripps Institution of Oceanography, University of California, La Jolla, Calif.

Born: Marysville, Ohio, May 3, 1908; married 1936; two children.

Major field of interest: Oceanographic instrumentation.

Education: Oberlin College, A.B., 1931; University of Pennsylvania, 1935–36; Harvard, 1937–38.

Professional career: Assistant psychologist, Oberlin College, 1932–34; 1936–37; research associate, Fertility Clinic, Free Hospital for Women, Brookline, Mass., 1939–40; research instructor, psychology, Oberlin College, 1940–42; field engineer, technical staff Columbia University Division of War Research, 1942–43; research associate and field representative, University of California Division of War Research, 1943–46; chief engineer, Motion Picture and Sound Division, Dayton Acme Co., Cincinnati, Ohio, 1946–48; biologist, research engineer, and head, special developments, Scripps Institution of Oceanography, University of California, La Jolla, Calif., 1948– .

Member: Acoustical Society of America; Physiological Society of Philadelphia; Instrument Society of America; Sigma Xi; Journal of Marine Research, member of Editorial Board; associate director, Division of Marine Sciences, ISA; special consultant, American Institute of Biological Sciences; member of panel on new devices, and Air-Sea Interaction Panel, Committee on Oceanography, National Academy of Sciences; member, Eastern Pacific Oceanographic Conference Committee on Radio Transmission of Oceanographic Data; chairman, session on Recent Wave Measurements for Ocean Wave Spectra Conference, National Academy of Sciences.

Scientific contributions: Extensive research in field of deep sea instrumentation. Effects of high hydrostatic pressure on electronic components. Development of techniques for operating transistors, etc., at high pressures. Development of practical deep sea oceanographic telemetering cables and techniques, including precision telemetering current meters, photometers, oxygen meters, bathythermometers, etc. Publications in the field of biological and physiological sciences on electromyographic studies and biothermal electric potentials and oceanographic instruments. Patents on oceanographic instruments.

The Chairman. Mr. Reid, I understand that you want to file your statement?

Mr. Reid. Yes, sir. I have made a distribution of copies. Considering the short time available, and the fact that I must leave tomorrow morning, I would be very happy it you would allow me to file my statement as read.

The Chairman. Thank you. We appreciate your cooperating with us. We will put the statement in the record in full, as if read.

STATEMENT OF J. L. REID, PHYSICAL OCEANOGRAPHER AT THE TEXAS AGRICULTURAL AND MECHANICAL COLLEGE, COLLEGE STATION, TEX.

Mr. Reid. Senator Magnuson and members of the committee, my name is J. L. Reid. I am a physical oceanographer engaged in research at the Texas Agricultural and Mechanical College. My appointment there is only temporary, as I am on leave from the Scripps Institution of Oceanography of the University of California, to which I shall return about April 1, 1961.

I am sensible of the honor I have received in being allowed to appear before this committee and to speak on a matter of particular interest and importance to myself and to the other members of the Eastern Pacific Oceanic Conference, that is, the matter of oceanographic data from picket vessels mentioned in sections 7f, 13f, 14, and 17f(3) of S. 901. The EPOC organization is a completely informal group of people engaged in and interested in studying the Pacific Ocean. The attendance includes members from the Bureau of Commercial Fisheries, the Naval Electronics Laboratory, the U.S. Coast Guard, the U.S. Coast and Geodetic Survey, the Weather Bureau, the Hydrographic Office, the National Science Foundation, the Scripps Institution of Oceanography, the University of Washington, Oregon State College, Humboldt State College, University of Southern California, World I.G.Y. Data Center A at Texas A. & M., the California Department of Fish and Game, the Inter-American Tropical Tuna Commission, the Stanford Research Institute, the American Tuna Boat Association, and the California Fish Canners Association. Because of the informality, attendance has also included in an unofficial but active and useful capacity representatives from the scientific communities in Canada, Japan, and Peru.

Our common interest has been the study of the Pacific and our purpose has been to discuss our mutual problems, and in those situations where joint efforts seemed desirable, to recommend and coordinate such efforts. Our two outstanding accomplishments to date are two cooperative hydrographic surveys. The first of these took place in the summer of 1955 and covered the area north of 20° N. latitude in the Pacific. The second took place in the summer of 1956 and extended the coverage to 10° S. latitude. The first venture included the use of a total of 15 research vessels from Canada, Japan, and the United States. Its data, and an atlas prepared from the data were published last year. The second venture included the use of a total of 11 research vessels from France, Japan and the United States, and its results, including an atlas, are in the final stages of preparation.

At our annual meeting in 1959 the subject of the five Navy picket ships off the west coast of the United States was introduced, and a committee was appointed to examine whether various oceanographic measurements might not be made from these ships without interfering with their prime purpose. This committee, chaired by Mr. J. F. T. Saur of the Bureau of Commercial Fisheries reported its work and presented a proposal at the meeting held in November 1960 and I shall quote from their report the following items.

> * * * two programs of observations are presently being carried out aboard these ships through the cooperation of the Navy personnel. In late spring, an albacore trolling program was started with BCF San Diego furnishing the equipment, and in the past few months temperature equipment has been placed aboard 8 of the 11 ships by BCF Stanford and San Diego, for the purpose of making surface temperature observations to compare with the injection temperatures. * * *
>
> It should be emphasized that, in the above work and contacts, the attitude and cooperation of the officers of the squadron commands and of the officers and men of the ships have been outstanding. They have further signified a willingness to cooperate in all reasonable ways, consistent with the primary mission of the picket ships, to make possible a full-scale program of oceanographic observations. * * *

At a meeting in Eugene, Oreg., in June 1960, attended by a member of the committee members and several other interested scientists, it was concluded that a program of observations from the picket ships would be of great value to oceanographic research in the northeastern Pacific, was justifiable, and was feasible. It was further decided that a comprehensive program with broad justification would stand the best chance of receiving financial support and that an attempt should be made to prepare such a program proposal. * * *

Some of the uses for the data, as indicated from the responses to the questionnaire are given below. The observations would provide in a general sense:

(*a*) Fundamental time-series observations on the average climatic and temporal variability of physical and biological conditions in the California Current region.

(*b*) Valuable reference data for the interpretation of synoptic surveys in the surrounding or neighboring areas by indicating whether the surveys were made at a typical or an atypical time or during the transition from one time to another, and

(*c*) Along with those taken at Weather Stations PAPA and NOVEMBER, a basic network of stations taking time-series data in the northeast Pacific.

More specifically, this program would provide, in relation to work of EPOC laboratories:

(*a*) Augmentation of the surveys in the northeast Pacific and Gulf of Alaska by POG, off the Washington coast by U. of W., off the Oregon coast by OSC and off the California coast by the CalCOFI program.

(*b*) Data on the occurence and movement of phytoplankton, zooplankton, and nekton for research at UBC, U. of W., OSC, SIO (MLR), and BCF (La Jolla).

(*c*) Data on migration and ecology of albacore for Oregon Fish Commission and BCF (San Diego) and of salmon for Fisheries Research Institute (University of Washington) and BCF (Seattle).

(*d*) Reference points for northeast Pacific surveys to be undertaken by U.S. Coast and Geodetic Survey under the NASCO recommendations.

(*e*) Time-series data for Pacific research on the variability and prediction of temperature and other physical conditions in the upper layers essential to military problems of the Hydrographic Office and carried on at SIO by contract with various governmental agencies.

(*f*) Facilities for operational testing of unmanned buoys under varying conditions. * * *

The proposal for a program of oceanographic observations at west coast radar picket ships reads in part as follows.

Time-series data from single locations in the ocean represent one of the most valuable research tools for increasing our understanding of the marine environment. Time-series observations in the fields of geophysical and biological sciences often form the foundation for later fundamental research papers which never could have been prepared had not the observations been taken with only "the good of the science" in mind at the time. But for more immediate application, time-series data in the ocean are invaluable in the interpretation of synoptic surveys in the surrounding area. They serve to indicate whether the synoptic survey was made at a typical or an atypical time or during the transition from one time to another. Finally, time-series data establish the character of temporal fluctuations, the average conditions and magnitude, and changes of variability. In this way they advance our ability to forecast the variations in oceanographic conditions which can be applied in numerous ways, e.g., (*a*) the prediction and availability of commercial fish species, and (*b*) the prediction of thermal structure and sound conditions in the ocean for military purposes. * * *

* * * extensive sampling of biological populations cannot be accomplished through the use of unmanned buoys, as presently conceived. We should, therefore, avail ourselves of the existing opportunities to collect these data from ships that are presently manning ocean stations for other purposes. Because of the amount of ship traffic, the wide continental shelves on which numerous lightships are located, and military emphasis, this has been done to a fair extent in the North Atlantic Ocean. However, very little of such data have been taken in the northeastern Pacific Ocean. The only significant contribution has been the observational program at weather ship *Papa* in the Gulf of Alaska, which has been conducted by the Pacific Oceanographic Group of Canada during the past 4 years. These data have benefited research at numerous west coast labora-

tories, but the United States, which has the most vital interest in the northeast Pacific of any country in the world, has been guilty of gross neglect in its failure to institute programs for obtaining time-series oceanographic data in this area.

The five radar picket ships which are stationed along a north-south line about 300 miles off the west coast of the United States present an unparalleled opportunity to institute a program of invaluable time-series oceanographic observations at a cost far below that required when special survey ships must be operated for that purpose alone. Proposed here is a program of basic oceanographic observations from these radar picket ships.

The observations from this program will supply fundamental information on oceanographic conditions (physical, chemical, biological, and fishery) and flow of the California Current, which is important to the research of all west coast laboratories. But the significance of this information will extend beyond this region, as the California Current is a part of the major current gyre in the North Pacific Ocean. Should the radar picket line be discontinued, the information will make possible efficient planning for later observations by other station ships and/or unmanned buoys. Finally, in addition to providing these data, the existence of the program and the equipment aboard the ships will provide a basic facility for scientists to conduct additional short- or long-term research problems which now can be accomplished only through the costly and inefficient use of oceanographic research ships.

RADAR PICKET SHIP OPERATIONS

The radar picket line located approximately 300 miles off the west coast of the United States is composed of five stations which are manned continuously. * * * The possibility exists that these stations may be relocated somewhat in the future but not enough to affect materially this program. * * *

While on station, the ships stay within a radius of 25 miles of the designated station location. This is accomplished by steaming generally upwind and downwind for the comfort of ships' personnel. As a whole, the crews are not busy continuously and both squadron and ships' personnel have been very receptive toward proposals for carrying out scientific work aboard the ships. Presently the ships' personnel are collecting data on two problems. With rigs furnished by the U.S. Bureau of Commercial Fisheries, Biological Laboratory, San Diego, they are trolling for albacore, keeping a record of the number of line-hours fished, measuring size of fish caught, and sending in special radio messages regarding sightings of large schools of tuna. With equipment furnished by the U.S. Bureau of Commercial Fisheries, Biological Laboratories at Stanford and San Diego, the weather personnel are taking and recording four surface temperature observations a day for a study of the differences between injection and surface temperatures. * * *

Research programs are acceptable to the Navy personnel under the following conditions:

1. All research programs are to be conducted on a "not-to-interfere" basis with the primary Air Force and Navy military objectives of the picket ships.
2. The ships are not to be responsible for any financial expenditures (equipment, etc.) in connection with the scientific program or for any of the scientific data.
3. Participation of Navy personnel will be on a "cooperative" basis, and scientific demands on them will be kept reasonable in scope. In other words, Navy personnel will not be held "unconditionally" responsible for the collection or handling of scientific data. * * *

These remarks and excerpts have been directed toward showing why we want the data and how we propose to get them rather than to describing the details of the observations we are seeking. Mr. Saur's proposal, however, does contain a meticulous listing of observations and instruments, together with cost estimates for obtaining the data and plans for the economical processing and handling and dissemination of the results.

I thank the chairman, Senator Magnuson, and the committee for this opportunity of putting forth the views of the Eastern Pacific Oceanic Conference upon this part of their bill.

The CHAIRMAN. Off the record.

(Discussion off the record.)

The CHAIRMAN. At this point in the record we will insert the statement of Mr. L. R. Sanford, president of the Shipbuilders Council of America.

(The statement follows:)

SHIPBUILDERS COUNCIL OF AMERICA,
New York, N.Y., March 14, 1961.

Subject: S. 901, the Marine Sciences and Research Act of 1961, and S. 1189, to Expand the Authority of the Coast Guard in Marine Research.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: It is understood that hearings will be held before the full committee of which you are chairman on March 15 through 18 on pending bills S. 901, the Marine Sciences and Research Act of 1961, and on S. 1189, to authorize the Coast Guard to carry on certain oceanographic research.

The shipbuilders council has for the past several years been keenly aware of the lag in this country as compared with Soviet Russia in basic marine science research and oceanography. The gap is most evident, of course, in the comparatively small number of research ships and related craft in active operation and in the failure to build new research ships. The council has as a result strongly favored expansion of all programs in this field and last year endorsed your bill S. 2692, the forerunner of the present perfected bill S. 901.

In view of a prospective world situation in which the ocean depths, like space, could play a vital role in our survival, the 10-year program envisioned in the bill is most timely.

The statement has been made that the needs for new research ships as covered by S. 901 will require a construction program that will compress 25 years of shipbuilding into 10 years. Actually, in terms of shipbuilding the program covered by the bill is quite moderate and there are more than ample idle private shipbuilding facilities available to accommodate the program without strain.

Subsection (e) of section 21 of S. 901 directs that all ships and surface or subsurface craft constructed pursuant to the act be constructed in domestic commercial facilities. The council strongly endorses this principle and appreciates your foresight in including such a provision in the authorization bill itself.

As to S. 1189, to enable expanded marine research activities by the Coast Guard, the proposal appears to be sound. There obviously is an area where the worldwide facilities of the Coast Guard would be most useful. However, as any such expansion of activity is a matter of internal Government administration, the council would prefer to follow the lead of the Coast Guard in respect thereto.

The shipbuilders council, on behalf of its members, urges enactment of the Marine Sciences and Research Act of 1951 and the rapid initiation of the vessel construction programs it would authorize.

The incorporation of this letter in the record of the hearing will be appreciated.

Very truly yours,

L. R. SANFORD, *President.*

The CHAIRMAN. We will recess until 10 o'clock tomorrow, and I thank you all for your patience.

(Whereupon, at 12:14 p.m., the committee adjourned, to reconvene at 10 a.m., Friday, March 17, 1961.)

MARINE SCIENCE

FRIDAY, MARCH 17, 1961

U.S. Senate,
Committee of Interstate and Foreign Commerce,
Washington, D.C.

The committee met, pursuant to adjournment, at 10 a.m., in room 5110, New Senate Office Building, Hon. Warren G. Magnuson (chairman of the committee) presiding.

The Chairman. The committee will come to order.

We have a substantial list of witnesses for today. The Chair wants to say that the President of the United States is going to send up a message either today or Monday to the Congress on this whole question of oceanography. I am familiar with portions of the message and the general aspects of the message. It may have the effect of not necessarily changing the administration in this field of oceanography, but at least I don't think we should make a decision until we get the message from the President.

I do want to create a good record here in all fields of oceanography—and many of our witnesses are in special fields—so that we will have that for the floor. As far as I know, most of the members of the committee favor this bill in general.

If we can devote our testimony today to the need for oceanography, and the need for more research in marine science, and maybe file what we have in the record regarding the administration until we get the message from the President to correlate it, it will help.

Dr. Henderson, I know you have to get away. We will call on you first.

This is Dr. Joseph Henderson, director, applied physics laboratory, University of Washington, Seattle.

It is good to see you.

STATEMENT OF DR. JOSEPH E. HENDERSON, DIRECTOR, APPLIED PHYSICS LABORATORY, UNIVERSITY OF WASHINGTON, SEATTLE, WASH.

Dr. Henderson. It is nice to see you, Senator.

My name is Joseph E. Henderson. I am professor of physics and director of the applied physics laboratory at the University of Washington. I am very pleased to appear before this committee to provide information which will, I hope, contribute to the passage of much-needed legislation in the field of federally sponsored oceanographic research.

The applied physics laboratory is one of many such organizations now existing for the purpose of providing the executive branch of the Federal Government, especially the Department of Defense and the Atomic Energy Commission, with the benefits of basic and applied research, conducted in a university atmosphere, where profit is not a motive. We are a small laboratory, having a total staff of about 125 people, but with a high density of Ph. D. scientists, as befits a university. We are wholly concerned with the problems of the Bureau of Naval Weapons of the Navy Department; except for a brief period of ONR support about 10 years ago, it has always been thus.

The laboratory began its existence in 1943 as part of the applied physics laboratory of Johns Hopkins University, whose name we borrowed and continued to use after separating from them as our programs diverged. Our reason for organization was to solve a serious torpedo exploder deficiency existing at that time, when the war in the Pacific was at its peak. The Johns Hopkins group was actively engaged in proximity fuze work at the time, providing a fruitful technical basis for the torpedo work. We have been involved in underwater ordnance work ever since.

During the war, the acoustic homing torpedo was born, and although the war ended before its influence was felt, torpedoes of this kind have received lively development to a present-day point of considerable sophistication. We can safely say that the acoustical properties of the sea are the heart of nearly all present antisubmarine warfare systems. The laboratory has provided a great deal of instrumentation for these antisubmarine warfare (ASW) weapons as a part of its tasks—in particular, the measuring apparatus and standards against which to measure their performance. These include calibrated artificial acoustic targets, and, more recently, three-dimensional acoustic underwater tracking ranges which reveal in detail all aspects of weapon performance against submarines. The best known such range is operated in Dabob Bay, off Hood Canal, by the Naval Torpedo Station at Keyport, Wash.; it is in daily use, with a heavy workload stemming from many branches of the Government, including the Bureau of Ships and the Atomic Energy Commission, as well as the Bureau of Naval Weapons.

I think I can safely say that this little chunk of water out there in Dabob Bay is probably the most important single bit of water, as far as antisubmarine warfare is concerned, of any that exists in the free world today. I think this is an important consideration.

The CHAIRMAN. How deep is it there?

Dr. HENDERSON. Approximately 600 feet deep, and over a considerable area, which makes it possible for us to work with most of our deeper weapons, as you can understand.

A similar system was installed off San Clemente Island in California about a year ago, and this was preceded by an important range experiment conducted in the deep, quiet fiords of southeastern Alaska—Chatham Strait, the finest waters of all for these experiments—is the summer of 1959.

The acoustic instrumentation described above, as well as other projects and studies concerned with weapons systems, has caused us to face time and time again the uncertainties resulting from an incomplete knowledge of basic ocean properties. In order to meet the needs for such knowledge, the laboratory established an oceanographic and acoustics study group which has grown to be about one-fourth of our scientific staff. This group not only supplies the studies and surveys required by our development programs, but also, in keeping with university tradition, conducts basic research. There is beneficial cross-fertilization here between practical and basic research. Two examples may be of interest. The underwater tracking range, mentioned above, which itself arose from basic research, is also utilized to make detailed studies of water current velocities throughout the depth of water by tracking the movements of a slowly sinking free body. Thus, this practical development—that is, the range—has supplied the instrumentation required for more basic investigations. A second example will illustrate the converse. One long-term study has involved the theoretical and experimental relationships between water circulation patterns at depth and the existence of regions of poor acoustic transmission. After the study was completed, it was found that these results allowed us to understand and predict the occasional poor performance of a particular weapon.

The CHAIRMAN. Would those acoustical studies that you people are doing out there have some benefit to pure communication underwater between, say, submarines or other underwater vehicles?

Dr. HENDERSON. I will have to answer that in a somewhat generalized way, because any study that you make of acoustic transmission, which is really the problem involved here, has the bearing of transmission of information from one body to another. Actually what we do is transmit information from the bottom of the submarine back to the bottom, and that is how we know where the object is located.

The CHAIRMAN. It is my understanding that one of our real No. 1 problems—some of it is classified of course—is the problem of communication between two underwater bodies.

Dr. HENDERSON. That is correct. However, to transmit a lot of information becomes difficult in the sea-water medium because of the low velocity of propagation of sound in the sea-water medium. You understand this when you realize that transmission by radio frequency proceeds at about 186,000 miles per second, whereas sound in water you have about 145 feet per second. So that the amount of information you can transmit is very small in sound compared by what you can do with radio-type transmission.

The CHAIRMAN. This is a real problem.

Dr. HENDERSON. This is a real serious problem for all underwater work.

The CHAIRMAN. And I suppose the degree of its effectiveness is determined by how much we know about the currents, about marine growth, all these things that would clog up those windows as we call them, of the sea?

Dr. HENDERSON. Particularly and perhaps the most important is the actual absorption or attenuation of sound of different frequencies in sea water. This is probably the dominant thing which determines what you can do in terms of communication. With long wave lengths of course, lower frequencies travel greater distances and are less absorbed than the higher frequencies.

The CHAIRMAN. I don't think it is particularly a classified matter, but this is a problem every place.

Dr. HENDERSON. Anything that deals with the sea has its problems.

The CHAIRMAN. This is the Soviet's problem, this is our problem, this is everybody's problem.

Dr. HENDERSON. It is even the whale's problem.

The CHAIRMAN. As we move down into the water.

Dr. HENDERSON. That is correct.

The CHAIRMAN. Therefore in this work you don't know what you might add to this.

Dr. HENDERSON. We have some pretty good information because we have been working at this quite a while. But there is a great deal we don't know, particularly about the structure of the sea. We know the general properties, but the detailed properties we do not know, and this is one of our objectives, to find out more of these detailed properties so that we can predict what will happen.

The CHAIRMAN. Marine life has a lot to do with it, too.

Dr. HENDERSON. Marine life does in most areas, close to shore particularly. Far from shore there is not much marine life which can cause us difficulty.

Most of the oceanographic investigations conducted by this laboratory have been made in Puget Sound. These waters present all the characteristics of a natural sea-water laboratory, so to speak, allowing detailed studies to be made quickly and economically.

Here again, in Dabob Bay, we speak of it as being an ocean in miniature. It has many characteristics of the ocean and can be extrapolated from the dimensions, size, depth, slopes, and gradients, temperature gradients, to the general ocean areas. For that reason we speak of it as our own little ocean laboratory, if you like. This again is Dabob Bay.

However, it must be recognized that generalizations about the open seas based upon work in these inland laboratories cannot be carried too far without considerable corroborative open-sea work. Recognizing this, the laboratory began about 2 years ago to develop specialized deep-sea instrumentation to carry out this work. The major effort has been concentrated on an unmanned, self-propelled, underwater research vehicle. You notice that is unmanned. This device has the external appearance of a torpedo. However, the hull is designed to go to a depth of at least 12,000 feet, and it will run at 7 knots for 8 to 10 hours, carrying instruments and recorders. I can give these numbers with confidence, since a prototype was used at sea last September at a depth of 9,000 feet. At present, this prototype is being instrumented for operations in June, and plans are being made to build four more of these vehicles. This device is to provide us primarily with (1) new sound velocity and new detailed bathymetry data of direct application to long-range sonars and fire control systems, and (2) the first measurements of detailed horizontal variations—as you go under the sea horizontally—of many oceanographic variables at great depth.

The CHAIRMAN. I might say one of the reasons, other than the scientific value of doing this, this real exciting experiment, is that it has been my understanding for some time that this is one of the real priorities in the Defense Department.

Dr. HENDERSON. That is correct. This is a strong motivation behind it, because you see what we are doing here is actually making the measurements down in the regions where your sonar beams travel. At the present time we know virtually nothing about that area.

It is interesting to note here that our present knowledge of the oceans is confined pretty much to the surface layers and, to some extent, the bottom area; the great midocean depths are the great unknown; yet here is where our important sonar beams travel. This vehicle will permit oceanographic investigation of 85 percent of the oceans. I was gratified to note the mention of self-propelled underwater research vehicles at several places in Senate bill S. 901, since we are confident that these devices will be of great general usefulness.

Our great need is for a seagoing oceanographic ship, properly instrumented and manned to carry out this experiment and others to follow. The prime purpose of this bill is to provide these facilities, not now available except on an occasional not-to-interfere-with-other-activities basis.

The proposed bill, S. 901, is intended to provide facilities for oceanographers to use in expanding their work. I am happy to note that the needs of military oceanography, in particular the TENOC plan, revised to include military oceanography as well as the Navy's revised long-range oceanographic program, are specifically mentioned in the reintroduced bill, since the expansion of this military-motivated work is just as essential as other branches.

You may remember, Senator, that I wrote you last year rather criticizing the bill last year because it didn't make adequate provision for this. I am happy to find that this one does take this into account.

We at APL are now doing work which will shortly require a seagoing vessel for about one-half its time. We have been making do with a vessel borrowed occasionally for a few days' time from the 13th Naval District, and have also gone piggyback on the university's oceanographic ship, the *Brown Bear*. We will need much firmed arrangements if we are to leave Puget Sound for any timely, meaningful deep-sea work. This also implies the need for added shore facilities, including piers, staging areas, warehouses, laboratory space, et cetera, all of which will be a part of the general oceanographic effort at the University of Washington.

Something is needed to stimulate support of research in oceanography, to provide the basic knowledge on which the Navy's future effectiveness depends. We believe our own work to be especially exemplary of this fact. I urge that the appropriate legislation be speedily enacted.

Thank you very much.

The CHAIRMAN. Thank you, Doctor.

There is a lot more that you could have said here, because you do a lot of classified work.

Dr. HENDERSON. This is correct.

The CHAIRMAN. Its importance is even greater than you have mentioned.

I appreciate your coming.

Dr. HENDERSON. Thank you very much.

The CHAIRMAN. Dr. Vine, chairman of the Panel on New Devices for Exploring the Ocean, Woods Hole Oceanographic Institution, Massachusetts.

We will be glad to hear from you, sir.

STATEMENT OF DR. ALLYN C. VINE, CHAIRMAN, OCEANOGRAPHY COMMITTEE PANEL ON NEW DEVICES FOR EXPLORING THE OCEAN, WOODS HOLE OCEANOGRAPHIC INSTITUTION, WOODS HOLE, MASS.

Dr. VINE. Thank you, Senator.

My name is Allyn Vine and I am a physical oceanographer at the Woods Hole Oceanographic Institution. It is a pleasure to be here today to discuss some of the trends and needs in the field of oceanographic instruments, ships, and devices. I hope you will feel free to ask any questions anytime.

It does not seem necessary to restate what is in chapter 7 of the oceanographic committee's report entitled "Engineering Needs for Ocean Exploration," because S. 901 shows that your committee has studied chapter 7 carefully. Perhaps this presentation will be most useful by emphasizing the ideas behind those recommendations, the progress in those directions and to mention subjects on which our panel was shortsighted or had misjudged trends.

My major field of interest is physical oceanography.

I was born in Garrettsille, Ohio, June 1, 1914. Degrees: A.B., Hiram College, 1936; M.S., Lehigh University, 1938.

Professional career: Research associate WHOI 1940–1950; physical oceanographer, 1950–; trustee, Ocean Resources Institute 1950–; trustee, International Oceanographic Foundation 1960—.

Member: American Physical Society, AAS, American Geophysical Union, Acoustical Society, Association for Applied Solar Energy.

Scientific contributions: Seismology at sea, current measurements, underwater photography, oceanographic instrumentation, underwater acoustics, design of research ships.

I would like to emphasize how very correct Professor Ewing was yesterday in saying that oceanographic instruments must be closely tied to the individual scientific problem and to the individual work in science. This does not mean that the scientist is always right, or that they don't need much help from the outside to keep from getting ingrown, but it does mean that the bulk of the instruments should be controlled by the scientific users.

The CHAIRMAN. You agree with his point yesterday that these are things that are developed by the individual himself. Usually they are not things on a production line.

Dr. VINE. That is right.

The CHAIRMAN. They may be elaborate or they may be simple. Let's say it is a custom-built job.

Dr. VINE. A custom job.

In this connection, I would also like to mention where industry can be and has been so valuable here, and that is in the business of taking these custom jobs and moving them into reasonable production so that other scientists for survey and research work can have the advantage of these good instruments with only a reasonable leadtime.

The CHAIRMAN. I know of cases where they have taken the instruments when they have been a semicustom job, industry has picked them up and made a custom job out of it themselves.

Dr. VINE. One interesting note is that several years ago in discussing this problem with some Soviet oceangraphers we agreed completely that if you only want one instrument where you sit down, you build it. If you want a hundred instruments, you call in a large outside organization and they get it built. But if you want only six instruments, then both our system and the Soviet system seem to have considerable trouble.

General: Oceanography has progressed in the past 2 years and several trends are apparent. During the past 2 years a great many more people in Government, in industry, and in private laboratories have become aware of the need for better oceanographic instruments. This has resulted in wide discussion, higher standards have evolved, some new instrument programs have been initiated, and such better ones are in the discussion stage.

In some areas progress is as good or better than recommended but as a whole progress has fallen behind our earlier recommendations. Particularly there has been a serious lack of funding for a variety of feasibility studies for advanced design instruments and vehicles.

The fact remains that it is generally much harder to find $10,000 to make a preliminary design study for a new device or ship than it is to find 20 times that amount for construction of a hurry-up design. This unfortunate fact is a direct but unnecessary result of the dilemma that "when there is time there is no money, and when there is money there is no time." Efficient administrative procedures must specifically include more funding earmarked for studies of advanced design on which to base later action.

Research ships: While our panel was not originally concerned with general purpose research ships, the importance of specialized use and advanced design make it advisable to consider ship design problems. The research ship is the most important of all oceanographic instruments and it is most gratifying to see that funds for new research ships have been allocated and that design or construction is going ahead on several very interesting ships. Between the needs of different laboratories and the different interests and experience of individual oceanographers and naval architects the variety and versatility of research ships are both improving rapidly.

The requirements for research and survey ships are sufficiently new that research ships are going through a very rapid evolution in design. There is every reason to believe that ship efficiency will continue to improve through several more major redesigns. Freezing on class ships too soon will be neither efficient nor economical. In fact, I cannot recommend too highly that each private and Government laboratory which needs a new ship be given funds to develop the ship characteristics and layout they need for their job. The National Science Foundation is to be commended on their efforts in this direction.

The CHAIRMAN. What is the status of that ship now? Have they laid the keel?

Dr. VINE. No, they have not.

The CHAIRMAN. It is in the drawing stage?

Dr. VINE. They hope in about 3 weeks that the big fat book specifications will be ready to put out.

The CHAIRMAN. That is right; it is in the blueprint stage now.

Dr. VINE. It has been slow, but we feel it has been very worthwhile because we have incorporated a great many things.

The Chairman. That ought to be a prototype for a lot of future plans which we have.

Dr. Vine. These preliminary studies should nearly always be done at the laboratory and by naval architects who visit the laboratories and individual scientists frequently. Commercial architects offer much in their being geographically close to the laboratory in question and in their varied experience with small craft.

The Chairman. They have a naval architect firm now.

Dr. Vine. Yes, sir.

Free interchange and criticism of ideas and plans seem to be all the design control that is needed or advisable.

Oceanwide survey: One trend in oceanwide surveys appears to be that an overall systems design and cost study covering objectives, instruments, ship design, and operating costs will help decide the best and the most economical expenditure of money. For example, the speed and size of a ship, the size of its technical and operating crew, the type of instruments it carries, all represent large factors in the overall efficiency of a survey operation.

Another promising trend is that it now appears both practical and wise to build echo sounders that record a three-dimensional picture of the bottom over a wide path on each side of the ship instead of producing only a single line of soundings. Such an echo sounder should revolutionize the ability of a ship to explore and survey bottom features. Two years ago our recommendations did not seriously count on assistance from the U.S. space program but we now believe navigation satellites such as Transit may become a standard all-ocean, all-weather navigation aid much sooner than we had dared hope for. Research ships offer a splendid opportunity for realistic evaluation.

The Chairman. What is your liaison now with the space group?

Dr. Vine. It has been very good.

The Chairman. It ought to be good, because they are going to endorse this program. They feel it is important, and they ought to be working with you.

Dr. Vine. We have been most heartened by our contacts. This is an excellent example.

The Chairman. If I give them enough money, they ought to be able to spill a little bit over on your side of it.

Dr. Vine. This is an excellent example of where an advance in one field certainly does help another.

The amount of data reduction equipment on ships is increasing and will continue to increase. This will result in better coordination with the National Oceanographic Data Center.

The above examples are to show that oceanwide surveys can become much more productive than appeared practical 2 years ago, but they should give many times as much data and information.

Deep manned vehicles: During the past 2 years the bathyscaph *Trieste* has made a record dive to the deepest part of the oceans but it has not had mother ship support for oceanographic research. Similarly on the east coast the deep submersible program involving *Aluminaut* is nearly underway but the problems of an appropriate mother ship have yet to be solved.

The Chairman. Jacques Piccard left here just 2 weeks ago. He has been working on a new project. In fact, he was up here and talked to us.

Dr. VINE. This is really what my next point is about.

Specific design studies on smaller submersibles that can be easily carried on the deck of any medium or large ship have not progressed sufficiently nor have specific enough design studies been carried out.

Manned buoys: The concept of an anchored midocean marine observatory or anchored buoy has only recently received serious design attention on the west coast and we can be hopeful that a successful full-scale buoy and program can be funded and carried out.

Unmanned buoys: Unmanned buoys have progressed faster than any of our other recommendations but still at only about half the recommended rate. This seems particularly unfortunate in view of the needs for better national and global weather predictions.

Other specialized research vehicles: Certainly our nuclear submarines *Skate*, *Sargo*, and *Seadragon* have shown that even a minor "ice suit" permits a nuclear submarine to have great mobility and usefulness in the Arctic.

It appears more certain than ever that a nuclear submarine appropriately designed or more fully converted for Arctic work could roam the Arctic almost at will for oceanographic research, logistic support, or rescue work. The preliminary design work recommended has not been undertaken and in view of the importance of the Arctic it is badly needed.

Realistic cost analysis studies for operating either a converted fleet submarine or a new conventionally powered submarine for general research work have not progressed as far as they should have. The Bureau of Commercial Fisheries is to be commended for their initial efforts in this direction.

The catamaran studies sponsored by the National Science Foundation and the University of Miami is another excellent example of a bold attempt to try and radically improve our seagoing capabilities in research.

The CHAIRMAN. The Science Foundation is sponsoring those studies, I believe.

Dr. VINE. They were sponsoring the initial design studies of getting people to explore which direction to move in next.

Specialized survey instruments: Many frequently used instruments for basic research and survey need to be procured in sufficient quantity to become generally available so that a partial standardization can be obtained. Such instruments are winches with electric cables; towed temperature recorders; magnetometers; recording buoys; echo sounders, et cetera; navigation equipment.

Recent meetings sponsored by ONR and the Hydrographic Office have emphasized this problem and tried to define acceptable specifications for such instruments. However, funding for dual approaches in prototypes and for appreciable production appears questionable.

High-seas engineering: Although outside of our original recommendations, we are all delighted that the Mohole project is progressing so well and has spent some time at sea. Any comparable efforts in mining, fishing, etcetera, have yet to be initiated.

Conclusion: In conclusion, I would emphasize that things are happening, but not as rapidly as recommended. Progress has been spotty, and not enough advanced ideas are being given serious design study.

Industrial participation and competence in this field is increasing and can be most useful when tied closely to seagoing R. & D. projects.

Thank you.

The CHAIRMAN. Thank you, Doctor. I appreciate your coming.

Dr. VINE. Thank you.

The CHAIRMAN. Dr. Hargis?

(No response.)

(Dr. Hargis' statement will appear subsequently in the hearing record.)

The CHAIRMAN. Dr. Donaldson is our next witness. He is the director of the Laboratory of Radiation Biology, University of Washington.

STATEMENT OF DR. LAUREN R. DONALDSON, PROFESSOR OF FISHERIES, AND DIRECTOR OF THE LABORATORY ON RADIATION BIOLOGY, UNIVERSITY OF WASHINGTON, SEATTLE, WASH.

Dr. DONALDSON. Senator Magnuson, the University of Washington, as you have inferred from discussions already presented to your committee, is an institution with a long history of sustained and enlarging interest in the marine sciences. I should like to talk to you today about two additional aspects of this interest, particularly as they relate to the measure before you, the Marine Sciences and Research Act of 1961.

The first of these interests concerns the training of students in fisheries science in the college of fisheries of the university, where undergraduate and graduate degrees in fisheries have been offered since 1918. Over the years there has emerged a new science of fisheries biology which has given the work of the college its special flavor and character, and I think this area is well described in the current annual report of the college. Permit me to quote here a statement from that report:

> The primary objective of fisheries science is the efficient use of our waters to produce food and to provide recreation. This has required the development of a new science of fisheries biology involving the application of fundamental principles of mathematics, zoology, chemistry, physics, botany, and engineering to the varied and complex problems concerned with exploitation and control of the naturally renewable resources of the oceans and inland waters. Fisheries biology owes its independent existence as a branch of science to the need to integrate these diverse areas of knowledge and to extend some of them to fit the situations resulting from the peculiar nature of the environment in which marine and other aquatic animals live and to the need to consider both the environment and the living populations quantitatively as well as qualitatively. The members of the faculty in the various branches of the college are thus concerned with a variety of problems and subjects each related to his particular field of interest and competence. Consequently, research projects presently under investigation range from those of immediate practical significance to others primarily academic which are quite remote from any practical application. However, all science is directed to some extent toward the satisfaction of both the intellectual and the physical needs of mankind and fisheries is no exception to this ("Research in Fisheries, 1960." College of Fisheries, Fisheries Research Institute, University of Washington, Seattle, Wash., contribution No. 116, p. 2. (1961)).

The research projects conducted within the college of fisheries, both by members of the faculty and by the graduate students in the fulfillment of their graduate requirements, are supported to a very large degree by the Federal Government and by the fishing industry of the

Northwest and Alaska. But the need for specialized research in fisheries produces an ever-increasing need for research workers with specialized training, and this in turn enlarges the need for more comprehensive support of research and research training. This is true at our institution and I am sure that it is true at others. The passage of the Marine Sciences and Research Act of 1961, whereby funds may be appropriated specifically to increase the research potential and graduate training in the universities, therefore, will be altogether in the national interest because it will provide a wider base on which the universities may work to improve and preserve important national resources. For the record we should like to submit a more comprehensive statement of the role of fisheries under this act.

It is an important fact that the training programs of the college never have produced enough trained personnel to fill the positions available. It presently is calculated that twice as many positions exist as the college will be able to fill from among its graduates. It is relevant, too, that 11 percent of the fisheries students come to Washington from outside the State and that 15 percent come from foreign countries. This demand is continuing and certainly will not diminish in the foreseeable future.

The CHAIRMAN. I think the interest in foreign countries is going to become much, much greater. That has some intangible values for us, too.

Dr. DONALDSON. Some very real, important international aspects.

The CHAIRMAN. We are going to encourage the new African countries, which have a food problem with the great fisheries lying right off their shores, to do something about it. This will result in all kinds of encouragement of students to come to these fisheries schools, of which a great number will want to come to the University of Washington because of its reputation and established character in this field.

Dr. DONALDSON. At the present time Uganda's Director of Fisheries, Mr. Al Achaniz, a politically important person in that country, is attending the University of Washington, taking an advanced degree. Iceland's Director of Fisheries, Mr. Thor Gudjonsson, is also attending the university and taking an advanced degree.

There also is a second area of interest which I should like to review briefly. This concerns the development of the atomic energy program and its relationship to studies of things living in and near water.

I am very pleased to note that the bill has a section including oceanography and its relationship to the atomic energy program.

In 1943 it was decided that the waters of the Columbia River provided the best possible source of coolant for the atomic reactors then being planned, and subsequently built, near the town of Hanford in the State of Washington. No information was available—none, in fact, existed—on the possible effects of such use on the waters of the river or on the biological organisms, including the fish, within them. The University of Washington, as an institution already concerned with fisheries biology and located in the near neighborhood of the new Hanford plant, was asked by the Office of Scientific Research and Development to establish a special research facility to evaluate the basic problems. The applied fisheries laboratory thus was created to study the effects of various amounts of radiation on aquatic forms, and these studies it conducted for the Manhattan Engineering District and, after 1946, for the Atomic Energy Commission. The laboratory became, in 1958, the laboratory of radiation biology, and it has continued, under the auspices of the Atomic Energy Commission, to play a significant role in biological studies for—

> the purpose of determining the effects of radioactive contamination upon the oceans and life within the oceans and their estuaries (Marine Sciences and Research Act of 1961. Bill S. 901, Feb. 9, 1961, p. 30).

From the small beginnings of 1943 the work of the laboratory expanded as the range of potential radioactive contamination grew wider and the problems more diverse. The marine phase of the laboratory's work was initiated in 1946 when members of the staff participated in the atomic tests at Bikini Atoll. As the test devices increased in size, and as the areas of "near-in and intermediate fallout" became larger, the "field laboratory" ultimately became a great area of ocean spread about the nuclear test atolls of Bikini and Eniwetok, an area encompassing about 1½ million square miles and extending from the eastern part of the Marshall Islands to the Marianas and from the Equator to about 15° N. In an area of this size the laboratory, supported by the Commission, the Department of Defense, and appropriate elements of the armed services, particularly the U.S. Navy, attempted to provide essential information on the distribution and possible effects of radioactive contaminants introduced into the marine environment as a result of nuclear tests. This work was by no means merely for the purpose of monitoring fallout, an activity conducted efficiently by other agencies, but rather to accumulate understanding of the behavior of radioactive fallout placed in the biology of an atoll or in that of the ocean itself. The program was an aspect of that new and larger field of radiation biology. It was then, and it is now, a program of research requiring appropriate research equipment and field facilities.

During the 15 years that the laboratory has been concerned with evaluating the biological effects of the weapons testing program, shore facilities in the field have been provided by the Atomic Energy Commission at Eniwetok, Bikini, Kwajalein, and Rongelap Atolls—the last an atoll on which the laboratory has participated in long-term studies flowing from the accidental contamination of 1954. Transportation to and from the test area and the offsite stations, as well as transportation for the oceanographic surveys, has been provided by the Department of Defense.

Navy vessels of many types—LSI's, LSM's, LST's, DE's, and others—have been used in the radiological surveys. The laboratory has indeed appreciated the efforts of the Navy to provide facilities and services; however, a destroyer escort or a modified landing vessel is a poor substitute for a properly designed, equipped, and manned oceanographic survey ship capable of serving as a research base for radiological studies as far reaching as those in which the laboratory of radiation biology has been engaged.

The CHAIRMAN. I would think that this type of study has got to go even further than the military operations in that area because it is a subject cropping up every once in awhile in different activities in Congress. What is the real effect of the dumping of radioactive wastes in different places? Where do you dump it? Everybody, of course, is suspicious of it.

Actually a controversy occurs when you try to get the experts to give their opinion on it. It seems to me that these tests are going to have to move into that field, too, so that we can come to some fairly accurate conclusion as to what the effects are.

Dr. DONALDSON. The entire field of radiation measurement in the sea, and its effect, is a tremendous stimulus for both support and general interest.

The initiation of the Chariot program of Operation Plowshare in 1959 introduced a new phase in the university's oceanographic-radiobiological studies, in which the facilities and experienced personnel of the department of oceanography and the laboratory of radiation biology were combined in a joint effort. In the 1959 and 1960 surveys of the Chukchi Sea and adjacent areas of the State of Alaska, as part of Project Chariot, substantial contributions were made to the knowledge of physical and biological oceanography of the Arctic seas, fisheries potentials were explored, runs of salmon enumerated, and the radiological contamination of the area was measured.

Another team study is being conducted in the lower Columbia River estuarial region and in the adjacent sea to determine the distribution of the Columbia River waters in the Pacific Ocean. In addition to making the usual oceanographic studies, the university teams are also seeking to evaluate the amounts and kinds of low-level contamination from radioisotopes introduced into the river, and thus into the ocean, by the Hanford Atomic Products Laboratories. This unique opportunity to develop a better basic understanding of the fate of radioactive materials in a marine environment should be exploited to the fullest.

In spite of the herculean efforts of the past 17 years by biologists to understand and evaluate the problems created by the use of atomic energy, much still remains to be done. We have, in a sense, really only learned enough to begin to see what directions our future work should take. As Dr. Detlev Bronk has aptly stated:

> As the use of atomic energy becomes more and more a part of our daily life it is essential that thoughtful attention in broad perspective be paid to the often subtle and perhaps profound effects of this new technology of man and his environment ("The Effects of Atomic Radiation on Oceanography and Fisheries." Foreword. National Academy of Sciences-National Research Council, Publication No. 551, p. VII. (1957)).

The advance of nuclear technology will produce quantities of various kinds of atomic wastes under a wide diversity of conditions. The techniques of biological evaluation must not merely keep pace with these developments but must anticipate them, proceeding so rapidly that the evaluations may be elements of proper planning rather than programs born "too little and too late." The development of space programs using nuclear devices, of underwater nuclear powerplants and nuclear submarines, of nuclear-powered merchant ships, of harbor excavation projects and of nuclear devices for creating new Panama Canals, all will require a much more precise knowledge of the means for disposing of radioactive wastes. We need in the immediate future intensive work on such problems as the ultimate fate of radioactive materials in the sea, on the rates of sedimentation and the bonding upon bottom materials, on the biological recycling of radioactive materials, and on the selective uptake of materials by aquatic organisms. These are merely some of the directions in which research may move.

Very urgently needed, too, is a broad educational program involving more trained high school and college instructors working in the special fields of radiation biology.

I might comment that with the support of the National Science Foundation and the Atomic Energy Commission we have established an institute for training high school and college teachers. We have a total of 60 spaces available.

The CHAIRMAN. Generally there is a shortage now in this particular field in personnel.

Dr. DONALDSON. There were some 60 spaces available during the year. We have some thousand applications for the 60 spaces.

Predoctoral and postdoctoral fellowship programs must be expanded to train research workers in radiation biology. Unquestionably there must be, too, the cultivation of a wider public understanding of the nature of radioactive materials and their effects upon living things in the hope that, through such understanding, unreasoning fear can be overcome. I can't overemphasize this. It is such a very vital role we have to fulfill.

The CHAIRMAN. I didn't know you had that statement in there or I wouldn't have made the comment that I did make off the record.

Dr. DONALDSON. You are very well aware of our interest in this field from our previous conversations. Whatever we can learn of the biological effects of radioactivity will help us by that much to manage more effectively the atomic energy programs which hold out so much hope for good. But whatever is learned also must be interpreted, somehow, for the benefit of people everywhere.

The Marine Sciences and Research Act of 1961, if enacted into law, should go a long way toward coordinating the many aspects of the marine sciences and provide the facilities and support so badly needed. We sincerely hope that it will be passed by the Congress.

The CHAIRMAN. Thank you, Doctor. I appreciate your statement in this particular field of marine sciences because I think it is one that is going to affect the public interest and public support of progress in this field more than anything else, although there are still some skeptics and some doubts. Until we can show what the results may be, we are going to have a little trouble in moving ahead.

Dr. DONALDSON. I think as a summary statement, Senator, I should like to say that the real problem, the real need in the next few years is to learn to live with atomic energy, to live with it in its broadest sense.

The CHAIRMAN. I would like to spend a little time with you on your fish-breeding projects, but we have other witnesses here. Is that in here?

Dr. DONALDSON. No, sir, it is not.

The CHAIRMAN. I wonder if you could prepare for the record a short statement on just what you have been doing in that field. I think it would be very valuable for our record in this whole field of marine sciences.

Dr. DONALDSON. I would be very happy to do that.

The CHAIRMAN. Thank you.

Dr. DONALDSON. Thank you, sir.

The CHAIRMAN. Our next witness is Mr. Milton E. Brooding, representing the National Canners Association, Washington, D.C. Mr. Brooding is chairman of the U.S. section of the International North Pacific Fisheries Commission.

STATEMENT OF MILTON E. BROODING, REPRESENTING THE NATIONAL CANNERS ASSOCIATION, WASHINGTON, D.C., AND CHAIRMAN OF THE U.S. SECTION OF THE INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

Mr. BROODING. I appreciate the opportunity of testifying before your committee. My specific interest is in the fisheries of the great Northwest and Alaska. That is your backyard. It presents an increasingly important problem.

I am director of industry relations for the California Packing Corp., with headquarters in San Francisco.

I appear today as a representative of the National Canners Association, of which my firm is a member. The National Canners Association is a nonprofit trade association whose 650 members are located in 48 of the 50 States as well as in the territories. Members of the association pack over four-fifths of the entire national production of canned seafood.

As you have stated also, I am chairman of the U.S. section of the International North Pacific Fisheries Commission. This Commission is composed of the United States, Canada, and Japan, and has been engaged for 7 years in the promotion of conservation and maximum sustained productivity of the fisheries of the great North Pacific Ocean.

The CHAIRMAN. I might say for your information that we have been successful in getting the Department of Interior to include in their supplemental budget a recommendation for a relative research program in the Gulf of Alaska, the two areas that we are now in, so that we can get there this season. The amount is $3,000,000 plus. The budget request will come before a subcommittee of the Appropriations Committee. As far as I know, I am a member of that subcommittee. It is my expectation that we will keep it in the supplemental bill, so that it ought to be available in the next 30 days for us. That will then encompass the whole area we think should be looked at and provide sufficient research so that if in 1963 there is any move to change our position in the North Pacific Treaty, we will have the benefit of this basic data.

Mr. BROODING. I am glad to hear that, Senator, because what is involved in that research program is consistent with the purposes of your act. As a matter of fact it is a forerunner of some of the things that I am sure the act contemplates establishing on a permanent basis.

The CHAIRMAN. If the Japanese continue to tell us that we have not had enough research to prove some of our contentions, and we don't have everything we can get in this field, we might be in the same position in 1963 that we have been in the past.

Mr. BROODING. That is correct. I am very pleased to hear that.

The CHAIRMAN. I might also say for your Commission that I spent some time with the Soviet Ambassador the other day, and I have always contended that we can't have real conservation in the North Pacific without Russia being a party.

He agreed at that time to sound out his Government on this. I put it on the basis that they are members of the Northwest Atlantic International Fisheries Commission of which we also are a member, and that as fish don't know any politics, and political considerations have nothing to do with it, his Government should look into it. I received informal word from him on Wednesday that the Soviet Government was taking a good, long look at it. I think that is progress in some direction as far as your Commission is concerned, because it is their fish, too, particularly in the salmon area.

Mr. Brooding. You might be interested to know in that regard that at the last three annual sessions of the Commission, we have had Russian observers in attendance, noting what we were doing. So Russia is completely familiar with the concept of our conservation program and with the details of our research that have been developed.

The Chairman. Of course the State Department problem is the problem, as you know, between Japan and Russia. It is a sensitive area, I appreciate. But I do think we are making some progress to get them not only interested but maybe to become an active member. I hope that culminates.

Mr. Brooding. I think we all recognize that the fish of the sea do not recognize territorial waters or boundaries of countries. That is what makes the problem so difficult.

Fish canning plays a significant role in our national economy. Retail sales of all canned seafood products in the United States during 1959 totaled more than $550 million. In 1958, there were 12,600 persons employed in the seafood canning industry, with a total annual payroll of $38.2 million. The fishermen who provide raw material to our fish canner members work out of ports in the States of Hawaii, Alaska, Washington, Oregon, California, the Gulf Coast States, the Atlantic Coast States, the Commonwealth of Puerto Rico, Peru, Ecuador, Colombia, Mexico, et cetera.

Since its organization in 1907, the National Canners Association has placed strong emphasis on research and maintains three full-time laboratories in the United States. This association recognizes and upholds the importance of fundamental research in adding to man's basic storehouse of knowledge concerning his environment. It is somewhat ironic that our knowledge of the oceans, which comprise approximately three-fourths of the earth's surface, has lagged far behind our knowledge and exploration of land and sky.

Although we are blessed with an abundance of food in this country, other countries are not so fortunate. Our humanitarian concern for those less-fortunate countries is reflected in our national "food for peace" campaign and in the United Nations "freedom from hunger" program. Large units of the expanding human population of the world already suffer from the lack of sufficient protein in their diet. It is not inconceivable, in view of our expanding population, that we will someday also look to the seas for a relatively untapped source of high-protein foods, with which to replenish our own food supply as well as those of other nations. The sea remains one of our few great natural resources which has not been fully utilized.

It is not necessary for me to point out the implications of the proposed oceanographic research program to our national defense. During the course of these hearings, you will hear from more expert witnesses on that subject. There is, of course, an ideological factor involved in this program or, if you wish, our national prestige—about which we heard so much in the last presidential campaign—is at stake. The Soviet Union, as you all know, is rapidly expanding its fishing fleets and constantly increasing its production of fishery products. And there are good reasons for its success. You, Mr. Chairman, have stated that—

> Russia does not send out a single fishing boat, and they are operating on the seven seas, unless six or eight oceanographers are abroad.

The CHAIRMAN. That is on the large ones.

Mr. BROODING. That is right.

The CHAIRMAN. The bulk of the large ones have a pretty good team of oceanographers aboard.

Mr. BROODING. I venture to say that all of the smaller ones have proportionately good teams of oceanographers.

It is not necessary, either, to point out the fact that our American seafood industry must compete on the high seas with its Soviet counterpart as well as with the fishing industries of many other nations, both friendly and unfriendly to our way of life. Many of these nations are far ahead of ours in the study of oceanography. For example, in the North Pacific Ocean we have some of the world's greatest fisheries resources. The use of these resources by ourselves, but more particularly by other nations, is expanding with great rapidity, and will develop even more rapidly in the future.

In my experience it is imperative that we should have broad basic knowledge of the marine resources and the factors which control their abundance and distribution as far in advance as possible. This means that we must have answers before the questions are asked. The expansion of foreign fisheries throughout the world and in waters adjacent to our own coasts is proceeding with great rapidity, and will remain out of our control unless we can present convincing scientific evidence over broad fields of the oceanographic sciences.

Our lack of knowledge of marine sciences is, quite frankly, appalling. We need to know a great deal more about fish migrations, currents, the contours of the ocean floor, and similar phenomena. At present, the fishing fleets which supply our fish canners are required to spend long hours in seach of their fish. If we can learn more about the effects of various natural phenomena upon fish movements, we can reduce the time required for the catch and, thereby, reduce significantly our costs of production. In other words, the more we learn, the more we can increase the efficiency of our production. The lower the cost per ton of production by our fisherman, the lower will be the cost per can of fish to the housewife.

The high seas fishery resources we use are not under our exclusive control. Some are located in an international area subject to exploitation by all nations. The vast research program required to enable us to maintain and expand our share of these international fishery resources could not be justified on the basis of the interests of the fish canning industry alone. However, when we lump together our common interests in the national defense, the level of our national economy, our international prestige, nutrition and public health problems, and our commercial interest, it becomes apparent that there is an urgent need for a comprehensive program of oceanographic research which will rebound to the benefit of all our citizens.

For these reasons, the National Canners Association supports the objectives of S. 901 and urges its enactment by the Congress.

Senator, I would like to add one further comment with respect to the Russian incursion into the North Pacific, about which Alaska and the Pacific Northwest are deeply concerned. I think it should be a matter of record that the Soviet Union today has operating in the eastern Bering Sea, close to the shores of Alaska, a large fishing fleet composed of 3 to 4 factory ships, 15 to 20 large refrigerator ships, 60 to 90 trawlers, all serviced out of the Soviet Union by tankers and cargo ships, a flotilla fishing right off our shores.

This fleet is there. They have the knowledge of our oceanography, of our currents, of where our fish are located. We in the Commission are well aware of the fact that this is an expanding movement on the part of the Russians; that they do not intend solely to stay in that area but that they are coming south of the Aleutians. We expect they will follow down the shores of Alaska, past Kodiak Island, and a month ago, when I spoke to the joint session of the Alaska Legislature I expressed to them my deep concern about it, and Governor Egan and the legislators there all felt that it was a very, very serious matter. I think it does point up the need for an intensified program on the part of the U.S. Government in learning more about the ocean floor, the effects of the ocean on the fish, and where the fish are located. When I say our fish, I mean this: that we think the fish that are spawned and nurtured in the shores of our own country, even though they go to the sea, still are the product of our own fishermen, our own people, and that we should be entitled to their return in the harvest crop.

The CHAIRMAN. And we don't know whether they are practicing conservation or not.

Mr. BROODING. We have no indication of what they are doing, other than that the fleet is almost visible from shore, and it is operating in a very, very substantial way.

The CHAIRMAN. Thank you, Mr. Brooding.

Mr. BROODING. Thank you, Mr. Chairman.

The CHAIRMAN. Dr. Ray, we have kept you waiting a long time here.

STATEMENT OF DR. DIXY LEE RAY, ASSOCIATE PROFESSOR AT UNIVERSITY OF WASHINGTON, SPECIAL CONSULTANT IN BIOLOGICAL OCEANOGRAPHY FOR THE NATIONAL SCIENCE FOUNDATION

Dr. RAY. My name is Dixy Lee Ray. I am associate professor of zoology at the University of Washington. At the present time I am on leave from my university to serve as a special consultant in biological oceanography for the National Science Foundation.

It is a pleasure as well as a privilege to be here today—and yesterday, too—as one of the members of the NAS-NRC Committee on Oceanography to discuss particular phases of research that could be part of a national program in the marine sciences.

At first glance there does not seem to be a close association between medical research and oceanography. Indeed, we are accustomed to think of medical research as being largely restricted to the activities of dedicated men working in hospitals, health institutes, medical schools, and pharmaceutical laboratories. But this is not the whole story. Medicine has always benefited, in its continued progress toward understanding health and disease, from the knowledge gained in diverse fields from physics to psychology. To the increasing body of information, marine biology has also made its contributions.

As we testified at the hearings on S. 2692 last year, major medical discoveries have been made through study of marine organisms. To mention just a few:

The phenomenon of anaphylaxis, the trauma or shock reaction that may follow immunization and consequent sensitization to specific substances, was discovered about the beginning of this century by studying the effect of the sting of jellyfish and Portuguese man-of-war. We might add that neither the toxin itself nor an antidote to it is yet known.

Phagocytosis, the process by which white blood cells protect the body from invading bacteria, was discovered by experimenting—for other purposes—with young sea urchins.

Discovery of important vitamins concentrated in the liver of codfish and sharks—and coming ultimately from microscopic marine organisms that form a part of the food chain culminating in the fishes—is something that we all can recall, with varying degrees of distaste, from our childhood.

The transmission of nerve impulses along a nerve fiber and across synapses has been clarified through investigations on the unusual, giant nerve cells in the squid. The contribution of this animal to neurology is no less than that of the fruitfly *Drosophila* to the field of genetics.

This list could be extended to great length. But all of the medically important results so far acquired are small indeed compared to the potentially significant information that further study of marine organisms may yet reveal.

What are some of the areas in marine biology that are important from a medical point of view? They fall into several broad categories. There are, for example:

1. Studies related to the production or extraction of medically important substances from sea water or marine organisms;
2. Investigations of unusual toxins and their pharmacological properties;
3. Research on the nature of parasitism;
4. Analysis of physiological mechanisms, including both those that are widespread and those that are unique.

In some of these categories the relationship to medicine is readily recognized; in others it is obscure and indirect. To enlarge upon the former and to clarify the latter, some specific examples may be cited.

1. In the first category, a number of potentially important antibiotics are known to be produced by marine micro-organisms, and recently an effective antiviral agent has been found in the muscles of abalone. Vitamins, health foods, blood extenders, are all known to be produced by a variety of marine plants and animals. Carrageen,

extracted from certain red seaweeds—Chondrus crispus, or Irish moss—appears to be effective in the treatment of stomach ulcer. Utilization of these, and discovery of other medically important substances is possible, but only if research is carried out to reveal more knowledge about them and the circumstances under which they are produced.

Some marine animals harbor no enteric bacteria. Whether this is due to production of antibiotic or lysing agents by the digestive tissues is not at present known, but if it could be determined, the information might have implications for treatment of bacterially caused digestive ailments in man.

The CHAIRMAN. Are there not a lot of folk medicines, like seaweed and things of that kind, for stomach disorders? I know there are in Japan.

Dr. RAY. There is. And in the South Pacific islands, where people are closely associated with the sea. That information has been picked up and passed from generation to generation, as well as information about this second point, the harmful substances.

2. Many marine forms produce substances of astonishing virulence and toxicity to man. Examples of this are: the toxin of the notorious red-tide organism Gonyaulax which causes paralytic shellfish poisoning and is several times more toxic than the most poisonous nerve gases now known; the snail Conus whose sting can kill a man; the poisonous sea cucumbers and sea urchins, found mainly in tropical waters, that are lethal to fishes and are capable of causing severe disturbances in man; the sting ray and stone fish; the edible fishes whose flesh contains a virulent toxin, but only at some times and only in some geographical area.

There are at least three only partly related reasons for interest in exotic toxins. The first is of course to find effective antidotes and to learn how to use toxins as pesticides in a controlled fashion. The second is the experimental study of toxins and their actions for the information this may reveal about basic physiolgical mechanisms.

For example, study of the plant poison, curare, which has a specific action in blocking the passage of stimuli from nerves to muscle, has revealed much about the way nerve impulses are transmitted across this important juncture. Knowledge of the action of curare has also made it possible to use this potent poison safely in some surgical procedures.

Sea cucumbers produce a somewhat similar substance, called Holothurin, that has the same general action, but is many times more powerful. There are studies going on now trying to determine the chemical identity of this substance and to see whether it can be modified in various ways to control the specific action and make it also a useful substance. We know, at the present time, next to nothing about the possibility of its use.

Study of the wide variety of toxins produced by marine animals promises to add enormously to medical knowledge; only very recently has medical research recognized the potentiality of marine invertebrate pharmacology.

That the same species of fish may be edible in one geographical locality and lethally poisonous in another has now been established with certainty. To a lesser degree the same is true for many species of shellfish. At the present, neither the time nor the reason for the toxicity can be predicted; so for economic as well as for health reasons these phenomena should be studied.

3. Many diseases are caused by parasites. This holds both for man and for the animals that he uses for food. Much progress has been made in recognizing the symptoms of parasitism, but very little in understanding the underlying reasons for it. Among marine animals there are whole series of closely related forms, each showing different degrees of dependency or susceptibility to parasitism. There are also whole phyla in which parasitism is unknown; others in which it is the rule. Study of these animals, especially those where parasitism exists in its simplst or most primitive expression, will teach us much about the basic causes of the parasitic mode of life.

Bacterial diseases similar to or identical to tuberculosis and leprosy infect important food fishes such as salmon, yet other fishes and other marine animals in the same water environment are apparently immune to these diseases. Why this is so, no one knows. More knowledge of how the salmon are infected, whether the disease can be transmitted, and why other marine animals are immune, is badly needed. For some disease-causing bacteria sea water has apparently a sterilizing effect; conversely certain types wounds—e.g., scratches from corals, barnacles, sea urchin spines—are very apt to become infected. Reasons for this also are unknown.

4. Progress in medical science depends in large part upon progress in the knowledge of normal physiological functions. Unless the normal living animal is understood, the variations that we call ill-health or disease are meaningless perplexities. Obviously man can seldom experiment upon himself, but most physiological processes are basically similar throughout the animal kingdom and the study of other animals contributes importantly to knowledge that in turn contributes to human health and welfare.

Because they represent the greatest diversity from simple to complex, and because they show myriad variations both anatomically and functionally, marine animals provide essential information in many physiological studies.

We have already mentioned how understanding neurological phenomena have been clarified by the squid and other mollusks; at present there are experiments on the brain of octopus that are helping to elucidate the nature of learning and of mental disorders; from crabs and shrimps come substances that inhibit nerve impulses; in heart research lobsters, clams, and worms are adding their bit to the store of knowledge, for their cardiac responses are different from those of vertebrates.

One of the most active fields of medical research today involves studies of tissue compatability and the nature of immunity. Here animals we call sponges are especially useful experimental material for their tissues can be separated into the constituent cells that then are capable of reaggregating to form the typical animal once more. The eggs and embryos of marine invertebrates also contribute to this field. Their study is even more important in learning about the factors that stimulate cell division and control its rate—information that is basic to unravelling some of the perplexities surrounding the growth of cancer and neoplasms.

The CHAIRMAN. Dr. Ray, as long as you have suggested it, we have a statement for the record from Dr. Ross Nigrelli, director of the Laboratory of Marine Biochemistry and Ecology, New York Aquarium, who makes this statement, and this doesn't involve research but involves effects of things you are talking about on human consumption:

> Some years ago I indictaed to fisheries biologists that the possibility existed that our beautiful rainbow trout may be susceptible to liver cancer under the artificial conditions that are presently employed in our hatcheries. In the early part of 1960, liver tumors were noticed in rainbow trout in California and Washington, and this condition has since been found to be widespread in all hatcheries in this country. I am reporting this item to point out one of the problems that illustrates the importance of including the Public Health Service in your proposed program of marine science. Cancer is found among all fishes, and the growths are no different from those that occur in man and animals generally.

Is that a correct statement?

Dr. RAY. That certainly is.

I would like to add one bit to it, and that is a point I think I mentioned last year, too, which is a very curious one and so far still quite uninvestigated: that these growths—the hematomas, for example, in the rainbow trout—do affect fishes and, as Dr. Nigrelli said, man and animals generally. That is true if by "animal" we mean vertebrate animals. But it is a very interesting sidelight that among marine invertebrate animals—like clams, worms, star fish, and so on—there has never yet been a single case of cancer found. This may be because nobody has looked hard enough. But many of these animals have been looked at very carefully and studied anatomically; it is still unreported, a single case of cancerous growth in invertebrate marine animals. And if this should turn out to be true, I think this is a very important thing to turn our attention to, whether this type of growth is something that is rather unique for vertebrate animals and does not affect the invertebrates.

The CHAIRMAN. Of course, the immediate thing is to obtain as much information as we can get.

I have heard that this may come out of hatcheries—I think Dr. Donaldson and I talked about this once—it could be due to the type of food they give them. But if it is found in all fishes it must be the normal, natural food in the sea, probably. I point this up to show that this is a very important immediate thing that needs doing. The American people are consuming more and more fish, and that is good, because it is a great food and with the technological handling of fish, with refrigeration, it will become even greater. This is a very important thing for the American people, or other people throughout the world who eat fish.

Dr. RAY. The important thing is the need to do the research on it now before the problem becomes serious.

There are other questions, too, questions such as why whales and porpoises can dive to and return from great depths without suffering from the bends.

The CHAIRMAN. The Navy is working on that?

Dr. RAY. Yes, indeed.

The CHAIRMAN. They have some porpoises they are experimenting with.

Dr. Ray. And porpoises turn out to be very interesting animals.

The Chairman. I know they are working with pet porpoises on the Polaris program.

Dr. Ray. Not only for the way in which these animals move through the water, but for the implications of all deep-diving submersibles, information about the behavior of these animals is useful.

Another thing, such as why some species of marine organisms accumulate certain substances, including the radioisotopes, to an excessive degree over the concentration in sea water; what are the tolerances of marine life to the pollutants and insecticides that enter the sea in ever-increasing amounts. These are questions whose answers are or should be sought, and all have medical significance.

The medical implications of oceanography are vast. Some of the more important questions are being explored, but most are claiming attention of only a few investigators, and many are being ignored. That the present amount of medically-oriented work with marine organisms is so much less than might be expected from the intriguing questions that can be asked, is not due to the indolence of scientists but rather to the lack of opportunity for intelligently exploiting the possibilities of marine research.

In addition, these organisms, and particularly the invertebrate organisms, are generally less well known and appreciated than forms that have, like us, a terrestrial life. We are accustomed to the problems of maintaining colonies of animals, cultures of organisms, and crops of terrestrial organisms and using these for experimental purposes, but few laboratories are equipped to satisfy the needs of long-term experiments that involve the maintaining, breeding, and rearing of marine animals and plants, and yet this is what is needed.

To explore the medical aspects of oceanography means that there must be permanently established marine laboratories, located near the ocean shore, equipped with continuously operating sea water systems that deliver adequate supplies of fresh, unpolluted sea water available on a year-round basis.

For medical investigations, the marine laboratory must also have modern research equipment. The number of such marine stations, compared with the total number of laboratories in which medical research with terrestrial ogranisms can be carried out, is small indeed. Great laboratories are built to investigate questions of health and disease, and these medical research centers are vitally important, but most of them are far from the sea and none have provision for exploiting the rich reservoir of experimental organisms that live in the marine environment.

If we look to the open ocean where important medically oriented experiments could be carried out on shipboard, we find that only now are research vessels in the United States being planned to provide adequate research biological laboratories. Without these facilities, on shore and afloat, in which carefully controlled, modern research can be carried out, progress in the medical aspects of oceanography will be slow. We are still very far from achieving our goals, but the prospects of contributing through marine biology to the store of knowledge that leads to greater human health and welfare cannot be dimmed.

The Chairman. Off the record.

(Discussion off the record.)

The CHAIRMAN. Dr. McLaughlin, we will be glad to hear from you, sir.

STATEMENT OF DR. JOHN J. A. McLAUGHLIN, HASKINS LABORATORIES, NEW YORK, N.Y.

Dr. McLAUGHLIN. I am Dr. John McLaughlin from the Haskins Laboratories, New York. As we are a nonprofit institution, I am here representing my own opinion and not that of the institution.

In light of what I heard in the testimony this morning I feel that my contribution this morning will be very small, sir. I am naive or a juvenile in this respect. I have never had the occasion to address a body like this before. I hope I learn from this experience.

I took, sir, the bill and read it and reread it and went through it with the sense of seeing how it would appeal to me as regards my work. Consequently this statement is oriented along these lines.

The use of some terminology in S. 901 appears to require clarification. It is my opinion that the terms "oceanography" and "marine science" are used interchangeably—and they should not be. Here and there the word "oceanography" is used to include all the marine sciences, whereas in other places the word "oceanography" is used to indicate that it is separate from marine science; and yet again it appears as one of the disciplines coming under the general category of marine science. This latter, by dictionary definition, appears correct.

I have made a list of the places where this confusion in terminology exists—and suggestions to eliminate this confusion. In order to save the committee's time, I would like now to submit for the record this list.

The CHAIRMAN. All right. We will put that in the record in full.

(The list referred to follows:)

In the description of the bill "marine research" for "oceanographic research."

Page 2, line 7, "marine" for "oceanographic" (oceanographic scientists); line 20, "marine" for "oceanographic" (United States not be excelled in oceanographic research).

Page 3, line 5, "marine" for "oceanographic" (long-range program of oceanographic research).

Page 4, line 6, "marine scientists" for "oceanographers" (recruitment of prospective oceanographers); line 10—says advance this in name sciences.

Page 5, line 14, "marine" for "oceanographic"; line 19, "marine" for "oceanographic".

Page 6, line 18, "marine" for "oceanographic".

Page 10, lines 15 and 16, "marine scientists" for "physical, biological, chemical, and geological oceanographers".

Page 19, line 14, delete "and oceanography".

Page 26, line 23, delete "oceanography and ".

Page 27, line 6, delete "oceanography and".

Page 33, line 23, "marine" for "oceanographic".

Page 34, line 10, "marine" for "oceanographic".

Page 35, line 3, "marine" for "oceanographic".

Page 37, line 16, "basic and applied marine research" for "applied oceanographic research".

Page 47: Since the Coast Guard's role in marine science has traditionally been that of oceanography, the use of the specific term "oceanographic research" throughout the section on the Coast Guard is appropriate.

Dr. McLaughlin. I should now like to move on to consideration of the content of the bill. In regards to the present laboratories to be expanded, new laboratories to be built—referred to on page 3, lines 15–17—which alludes to "shore facilities adequate to service and supplement the research and survey fleets."

It would be my interpretation that these laboratories will be designed, expanded and specifically function as adjuncts to the vessels. This seems to restrict these laboratories and their research activities to that of functioning as service units and secondly as units supplementing the type of research carried on by the oceangoing researcher. I would change page 3, line 16, to read "shore facilities adequate both to conduct independent marine research and to service and supplement the research and survey fleets."

Now I would like to refer to page 9, lines 3 and 4. Here the sum of $8,250,000 is provided for the construction of shore facilities for marine research. Are these facilities only to be adjuncts to the oceangoing vessels? I hope not. I would hope that here lies the foundation for an intensified effort to unify the various scientific disciplines—chemistry, biochemistry, taxonomy, pharmacology, and others oriented to this program of expanding our knowledge of the ocean. Such a focal point for the synthesis of these disciplines should permit the conquest of such complex problems as the bloom of organisms that cause poisonous tides. Even further advances in medicine might be made, perhaps through the extraction of pharmacologically active substances from marine organisms and their environment.

As you know from the research papers which you have, sir, this has been one of our main concerns, the obtaining of organisms and what do they produce into the environment, what toxins, what stimulants, what vitamins.

On page 11 of the bill, lines 17 to 20, here again I suggest that the operation of these laboratories be made more flexible, and not so directly tied to the vessels.

I would like now to refer to page 16, line 6. I believe this section fails to consider the study of the productivity factors in the marine environment. The fish we consume were at one time "sun energy." The basic "grass" of the oceans is the small—microscopic—organisms nanoplankton and phytoplankton. This "grass" is at the bottom of the food-chain pyramid. It is consumed by the next higher order of marine life—the copepods—which in turn are consumed by small fish, themselves consumed by large carnivors—man's food. This "grass" to meat-on-the-table is based, therefore, on the production of untold billions of these micro-organisms. Vigorous laboratory and field studies on these organisms are important to the future productivity of our fisheries.

A minor point for your consideration:

There are several places in the bill where universities are mentioned. As colleges not affiliated in a university structure will undoubtedly continue to contribute to the advance of the marine sciences, it would seem just that the word "colleges" be added in the following places: page 5, line 14; page 6, line 17; page 7, line 6.

And I have one last point which I consider extremely important. In spite of the Navy's past record in supporting fundamental biologic research, this bill seems to exclude the Navy from this activity. It seems to me that this branch of our armed services, which spends more time under, on and over the ocean, should not be denied the opportunity to study its everyday companions.

The importance to the Navy of biological research dealing with problems of fouling is obvious. But there can be a military role to such biologic studies. Let me give you an illustration:

Consider the famous phosphorescent bay of Puerto Rico. This bay and the adjacent coastal waters abound with a microscopic organism, which when disturbed—as for example by the movement of a ship—gives off biological light. The wake of even a small outboard in the dark of night produces sufficient light to read a newspaper by. This phenomenon of bioluminescence is possessed by many marine organisms in many parts of the oceans. It seems prudent that such organisms be studied as they are potential tattletales of the movements of both ships and men.

The possible effect of such organisms on Navy operations is of course of some concern. But besides that there is a possible utilization of these organisms for defense. If these organisms could be cultivated and inoculated into our own coastal waters, where their growth could be controlled, they might provide a very convenient and cheap warning system against intrusion.

I believe that you can see from this illustration that it is not only necessary for the Navy to make field observation of distribution and occurrence of marine phenomenon, but also to engage in greenhouse experiments which permit rigorous analysis of such ocean companions.

In short, I am here to stress to you the importance of in vitro laboratory studies to the advancement of the marine sciences. To quote the eminent Dr. K. M. Rae of the Scottish Marine Biological Association, Edinburgh:

> We require, first, more realistic experiments in the laboratory designed to test the relative importance of various environmental factors in order to insure that we are measuring those which are significant in the sea.

I have one comment, sir, on your radiation business and the boat in the harbor. We know, sir, that these micro-organisms, as the witness before me indicated—Dr. Ray—that they concentrate radioactive materials preferentially against a gradient. You have a high concentration of trace elements—copper, cobalt—all of the real heavy radioactive materials—biologically dangerous. These are the food of the phytoplanktons. If these become heavily infected with radioactive materials because these particles are necessary for their own existence, their own metabolic activities, the phytoplankton infected, the smaller fish become infected, and when you get that trout or shad, you may be getting a strontium which has passed through this chain, as a concentrated factor.

The essence of our work is can we go into the ocean, pluck the organism out of the ocean, take it into the laboratory, and get it in a sterile media and there grab hold of it, using all the variables that we can control in the laboratory, and see what makes it grow? In a sense I am a farmer. We try to grow these things, to see what are the limits. Why, if the ocean is a homogenous mass of sea water and everything is equal in it, evenly distributed, why do you have, within a certain population, one organism suddenly becoming very dominant and causing complete discoloration of the water?

You will have a bloom, for instance in Long Island Sound. These blooms occur periodically. Why, sir, can you get this organism, much like you have that one stalk of corn out in the field, which grows 10 feet high? You take it and put it where? In your laboratory you nurture it, culture it, and reproduce it. Then you test it and see what it can do. This is what we want to do, sir; bring these things into the laboratory, see what they can do. We need the oceanographer. We need the salinity data, phosphate, nitrate, all of this information to give us a framework so that we can reasonably build experiments which will give us some idea of the potential of the organisms to exist in the environment. The Alaskan clam, the gonyaulax which the doctor made reference to, no one knew where this toxin was coming from. Now we have the organism in cultures, as you know. You can extract the toxin from the organism.

In a refrigerator in New York we can put a lot of people out of business with the toxin you can get from growing this toxin in bulk in a laboratory under controlled conditions. Now we can tell under what conditions does it die off; what are the limits of its metabolism; what light intensities. Again oceanography tells us the turbulence of water, et cetera.

The other phase of the work which is most important for us is this: I don't know whether you have seen coral reefs. If you have been in the South Pacific, you have. They are things of great beauty. All the invertebrate animals of the coral reef have symbionts in their tissues. These algae force these animals to orientate toward the sun. It is analogous to a tree telling us which way to turn. Beautiful anemones with the long tentacles, loaded with the symbionts organisms.

We have been able by certain techniques to extract the algae cells from the animal, grow the cells, axenically, study their nutrition, physiology, to determine what their relationship between this plant and this animal is.

One of the things which bothers me, and we always talk about this, is how does the animal know the algae is there; how does it know enough to turn around to the sun? If you take these animals now and bleach them out by putting them in the dark and cutting off photosynthesis, they don't care where the sun is. You permit them to grow symbionts back in again, and the animals will orientate to the sun.

I am sure you will recall that from one of the reprints.

These are the fascinating things. I love to do this work. If you ever go down 20 feet and sit in the bottom and look at the side of a coral reef, there is such beauty there. This is what keeps you going many times when the organisms don't grow.

In this type of research which I feel can excite the minds of the young. When I have lectured at various universities and made the same point with them. How does the animal know that the plant is there and how does the animal know there is the sun overhead, and extend its tentacle straight up, and, when it goes down, to move over. This brings in potentially psychologists, biochemists, a whole wealth of marine orientated biologists, pharmacologists. This is what we are trying to do, we are trying to grab these people. If you make it possible for us to support them with grants and research facilities, then I feel in a reasonable period of time we can extract from the ocean, which contains such a tremendous number of unknown quantities, we can extract thousands upon thousands of nutrients, new basic facts and fundamental principles underlying this tremendous body.

Every time you go to the ocean and somebody dunks and you take a drink of water, you would be surprised at the number of organisms that you take in. They are fantastic. In shape, they are beautiful. They have a beauty which is all their own.

There is one thing I would like to mention here. I noticed in the various parts of the bill you say, for example, no more than $10 million per annum or so much per annum. If we started today to get these students, coerce them into marine biology, make it so attractive to them that we build our forces, you can see that 6 years from now the NSF or Public Health Service—we hope the Department of Marine Sciences—would have enough good research applications to spend more than the sum that they potentially could spend the first year. Something will suffer, and it will be the people that we are supporting now in the graduate program about 6 years from now are going to mature, and we can say, "All right, now, you have worked in a little area; here is your problem. Apply for your support, and develop this area. Go to it. Get lost in it. Find out what we want to know."

I have heard today of the tremendous international implications. There is another point. Is it possible we can use the counterpart funds?

The CHAIRMAN. Yes, it is possible.

Dr. McLAUGHLIN. If we are going to raise these research scientists in our own laboratories, we know there is a lack of marine orientated people. They are biologists and we are trying to get them into the marine field, get their feet wet in the ocean. But England, Norway, Sweden, Japan, and so on, all of these places have had a tradition—Plymouth Laboratories—in marine biology. If we take the graduate student who has been in the school for 3 years and say, "Now we want you to go to England, pick up the information you can there, learn from them, their techniques, and come back and improve our system," this, I think, would be of great help to us.

The CHAIRMAN. That is a good suggestion. We can use counterpart funds.

Dr. McLAUGHLIN. That is wonderful.

The CHAIRMAN. I appreciate your enthusiasm. When the bill is on the Senate floor I wish you could get up and make the speech.

I think you will convince everybody that you are a good scientist because you want to know why.

Dr. McLAUGHLIN. I don't know about that, sir.

The CHAIRMAN. Thank you very much.

Dr. McLAUGHLIN. Thank you, sir.

The CHAIRMAN. Dr. Fleming, professor of oceanography and executive officer of the department of oceanography, University of Washington.

STATEMENT OF RICHARD H. FLEMING, PROFESSOR OF OCEANOGRAPHY AND EXECUTIVE OFFICER OF THE DEPARTMENT OF OCEANOGRAPHY, UNIVERSITY OF WASHINGTON, SEATTLE, WASH.

Dr. FLEMING. I am Richard H. Fleming, Professor of Oceanography and Executive Officer of the Department of Oceanography at the University of Washington, Seattle, Wash.

I speak to you today with a background of 30 years' experience in oceanography. Since my days as a graduate student at Scripps Institution of Oceanography, I have seen the science grow from a mere handful of research investigators, with less than a dozen graduate students in the entire country, to its present level of vigor. The report of the National Academy of Sciences-National Research Council Committee on Oceanography has effectively demonstrated that even the existing level of effort in the United States falls far below that required to meet the ever-mounting demands for better understanding of the oceans to satisfy the needs of our country in military security, resources, and scientific knowledge. I am honored to have this opportunity to appear before you in support of the "Marine Sciences and Research Act of 1961."

I speak to you as an educator who, from his own experience, knows the complex nature of the ocean and who recognizes the urgent need for major efforts in the education of the young men and young women who must carry on the basic research, surveys, and applied investigations that are envisaged in your bill. I speak to you as a scientist who realizes the deficiencies in his own training and who hopes that his students will be better equipped than he in knowledge about the sea, in the theories, and in the techniques of research that will enable them to truly comprehend the nature of the ocean and its role in the future of our planet. My remarks will be limited to oceanography and I will leave it to those who are better qualified to describe the needs in other aspects of the marine sciences.

During World War II, I was called upon to direct the oceanographic program carried on by the University of California Division of War Research at San Diego. During the early years, the efforts of this and other laboratories were primarily concerned with the critical problems of antisubmarine warfare. The important role of the oceanogaphic conditions in this and other types of military operations was soon recognized and the demands for oceanographers quickly exhausted the pitifully small supply of trained personnel. The laboratories and agencies concerned with the military applications of oceanography called upon the services of our colleagues in related fields of science and upon young students without previous experience in oceanography. These individuals attacked their assignments with zeal and imagination and notable advances were made in many of the military problems. However, it was all too obvious that the on-the-job training was not efficient and that the lack of oceanographic background of the personnel made it difficult to attack the new problems that arose during the course of the war. It was apparent that the United States needed an adequate reservoir of professionally competent marine scientists and full credit must be given to the Office of Naval Research and to other branches of the Federal Government for the opportunities that have been provided in recent years to enable students to pursue academic training in oceanography.

In recognition of the continuing importance of the ocean sciences to the Armed Forces, in 1946 a Division of Oceanography was established in the Hydrographic Office and I was appointed as its first Director. In the ensuing 5 years, during which the Division grew to a complement of over 200, my principal concern was the entirely inadequate number of professionally trained applicants for the available positions. Several universities were offering postgraduate courses but the supply of oceanographers was far too small to meet our needs. To carry on the surveys with the vessels assigned to the oceanographic program once again required on-the-job training. The initiation of a data compilation project, that has just recently reached maturity as the National Oceanographic Data Center, had to be undertaken by a group with but little experience in oceanography. Fortunately, we were able to call upon meteorologists to start a program of ice forecasting that has proved to be so valuable in recent years with expanded naval operations in high latitudes. A measure of the effectiveness of the work carried on during these difficult years is the recent expansion of the activities of the Hydrographic Office.

The CHAIRMAN. Doctor, you are doing better all the time, but the military problems of undersea warfare are still there. They become even more so than when you were at San Diego because of the new types of things we are developing, the military material.

I am not sure, considering the whole, that the problems are not even greater after more than 20 years than they were in San Diego.

Dr. FLEMING. I think it was mentioned several times this morning, particularly by Dr. Donaldson, that in certain areas we have only learned enough to begin to recognize the problems that face us.

I would certainly agree with you that this is exactly the case in these problems of undersea warfare and in military applications in general.

The CHAIRMAN. I don't like to continually mention some kind of a race in the world, for if the Soviet threat didn't exist, those problems would still be there. But with the existence of the Soviet threat and the known work that we know they are doing, surely that dictates that we do just what you are talking about in San Diego but in a stepped-up manner.

Dr. FLEMING. Yes, sir.

In 1951, after some 10 years as a frustrated "consumer" of oceanographers, I welcomed the invitation to accept a position as head of the newly created Department of Oceanography at the University of Washington. The challenge of becoming a "producer" of oceanographers was heightened by the added opportunity to develop an undergraduate program in the subject—something that had not previously been attempted. I would like to stress several points. First, the process of building up a faculty and of attracting students is time consuming. Although our department has been in existence for nearly 10 years, we are still revising and improving our course program. It also takes time to develop a supply of qualified students. Finally, it takes many years to produce a finished product.

Our first undergraduate major who entered as a sophomore in 1951 has recently completed his postgraduate training at Texas A. & M. College and has accepted an appointment to the faculty at Yale

University. The course of study is oceanography, at both the undergraduate and graduate levels, is demanding both in difficulty and in time. To obtain the necessary breadth in the basic sciences such as mathematics, physics, chemistry, biology, and geology, to develop a comprehensive understanding of oceanography, and to then achieve a depth of knowledge in some aspect of the biological, chemical, geological, or physical characteristics of the sea, requires much more than is usually expected from a candidate for a graduate or postgraduate degree. Because most of our graduate students transfer into the department without previous training in oceanography, they are required to complete the comprehensive series of courses taken by undergraduate majors before they proceed to advanced studies.

During the past few years, the numbers of undergraduate and graduate students in our department have been doubling every 2 years. Obviously, we have an abundant supply of potential students but we have already exceeded our capacity. We are now refusing admission to many well-prepared students because of insufficient teaching and research space and more particularly, because the small teaching faculty is seriously overloaded. We, therefore, have at the present moment a pressing need for additional teaching staff and facilities if we are to contribute our full share to the supply of the trained scientific personnel required for the expanded program in the marine sciences.

The purposes of a university are to preserve knowledge, to organize knowledge, to impart knowledge and to extend knowledge. Unless these four functions are kept clearly in mind in the expansion of oceanography in the United States, serious imbalances will develop. To extend knowledge through research without adequate attention to the other phases of the educational process will create shortages in the future supply of scientific personnel. To divert faculties from their unique responsibilities for teaching and basic research by inducements—financial or otherwise—to work on applied problems or to accept employment in industry can be equally damaging. In terms of the present and future welfare of our country, it is obvious that a strong and vigorous academic program in the marine sciences is the very foundation of the entire plan outlined in S. 901.

The CHAIRMAN. What is the situation generally. Say a good oceanographer has had proper training. There are, of course, many places for him in the teaching field, and I suspect some in Government. But what about in the private field, is there much opportunity for a young fellow who might be looking ahead who says, "If I don't want to teach and I don't want to go into Government, where am I going to go?"

Dr. FLEMING. Many of the larger commercial organizations now recognize not only the problems of the sea, but there are trained scientists called oceanographers who can assist them in their particular program. There is an ever-increasing number of positions available in the geological field, particularly the exploration and drilling for petroleum.

The CHAIRMAN. We haven't touched much on minerals in this hearing. That's the field that offers private employment.

Dr. FLEMING. Yes, sir.

The CHAIRMAN. I would suggest that the pay is not too good in the other type.

Dr. Fleming. In recent years there has been a sudden increase in opportunities in various electronic manufacturing companies and in the aircraft industry.

The Chairman. I know in the aircraft industry and, of course, in the industries that are contractors for the Navy in all fields of underwater activity. Would it be a fair statement to say generally that there are plenty of opportunities in the private field for a well-trained oceanographer today?

Dr. Fleming. Yes, sir. I feel very strongly that we should not just train to meet existing demands, but that if we do our job as we should and produce a well-qualified, well-trained imaginative scientist, that there will be many jobs open to him as his capabilities become known.

In other words, I feel that educators, through their best efforts, create a demand for their product rather than the other point of view which is directly expressed that there is no point in training people because there are no jobs at the present time. This is certainly not true.

The Chairman. I think that may be because this thing has been a little more dormant than it should have been, there is a prevailing impression, maybe with parents or with young people, that this is a field which, when you get into it is pretty well limited to Government activity or teaching activity.

We should do what we can to dispel that. I don't think we have done enough. There is a great future in private activity in this field, in all phases of it.

Dr. Fleming. In addition to formal classroom lectures and laboratories, the students in oceanography must have opportunities to gain practical experience in dealing with their subject by working at sea on research and survey vessels. At the University of Washington, research and instruction in marine biology began nearly 60 years ago. Oceanographic research received a strong impetus about 30 years ago when the Rockefeller Foundation provided $265,000 for the establishment of a research laboratory on the University of Washington campus. Extensive and intensive studies of the coastal and inland waters have continued ever since on an expanding scale. During the past 15 years, with financial support from such Federal agencies as the Office of Naval Research, the Atomic Energy Commission and the National Science Foundation, studies also have been made over large areas of the ocean extending from the Marshall Islands to Stations Alpha and Charley on the Artic ice pack. Undergraduate and graduate students have participated in such cruises and have assisted in the preparation of the scientific reports. During the past two summers, studies have been made in the virtually unknown waters in the Chukchi Sea, north of Bering Strait and bordering the northwestern coast of Alaska.

Experience in research at sea as well as in the laboratory, study of theoretical problems, development of new instruments, and observation of processes in dynamic tidal models, are all important aspects in the training of our students. To further broaden the experience of graduate students and also to take advantage of the unique opportunities for research that can be provided by other departments and colleges in the University, we have provided assistance in various ways to the Applied Physics Laboratory, the Laboratory of Radiation Biology, the Friday Harbor Laboratories, the College of Fisheries, and many other groups.

To paraphrase a familiar advertising slogan, "Students are our most important product." They deserve the best quality of instruction that can be provided, they merit the opportunity to use the latest and best research facilities if they are to be capable of meeting the challenges of the future and to complete their long and arduous education they must receive financial support.

The CHAIRMAN. There are a great number of reports, of course, from other countries. Is there any problem in the translation, in getting those reports available to our students and faculities?

Dr. FLEMING. I think that most of the published reports of foreign countries are available in this country. They may not be widely held in university libraries and so on, but are usually available on loan. We have vast amounts of material, original data, scientific papers of various kinds, in foreign languages, and particularly those in Russian and in Japanese are rather difficult to cope with. There are very few of our scientists or faculties who have any language capabilities in Russian and Japanese.

We now encourage students, in their language courses, to follow up both of these languages, not an individual student, it would be unusual to find a combination of Russian and Japanese—it would be rather overwhelming—but we certainly encourage them in one or the other. Some laboratories are fortunate enough to have a Russian-speaking or Japanese-speaking member on their staff.

The CHAIRMAN. The point I make is that we have tried here, in the Science Foundation, I know in the Defense Department and in the medical libraries, to appropriate quite sizable funds for translations. Those are available, of course, to you if you take the initiative and ask for them. A great deal of these reports come to you people in their original language and you have to translate them yourself.

Dr. FLEMING. Yes, sir.

The CHAIRMAN. And the implications therein. I suppose the IGY supplied some of this, didn't they?

Dr. FLEMING. Yes. This has added a great deal to the exchange of information.

The CHAIRMAN. In that appropriation we had some money, too, for translations. Of course, here we are very fortunate because we have the Library of Congress which can do it for us. We could send a Russian document there and this afternoon it would be back. Schools don't have that facility. I think that is very important that we have all these things available.

Dr. FLEMING. Yes, sir.

The CHAIRMAN. We are even going to have to know Chinese. Red China is moving along.

Dr. FLEMING. Of particular importance are the original observational data which may not appear very exciting, as they may be merely columns of figures, tabulations of observations. The data centers that were established during the IGY, and a part of this responsibility which I am sure is being inherited by the National Oceanographic Data Center, have been extremely helpful in not only making possible the exchange of this information but making it available to the investigator or to the laboratory in a form that he can use. In other words, with some translated headings or with a key to the tables that make them immediately usable by the scientist.

The CHAIRMAN. The data center, which is now down at the Navy, that envisions translations, too, does it not? Not only our own reports to correlate them, but I hope it envisions translations, too, in this field.

Dr. FLEMING. This is in many ways an emergency approach to the problem. Again speaking as an educator, I would like to see as many of our scientists as possible capable of consulting the foreign literature themselves. They may not be experts in the language, but with enough ability to find their way along, read enough material to know whether or not it then merits more detailed and precise translation.

This not only broadens the experience and knowledge of the investigator, but enables him to evaluate and thus avoid a lot of unnecessary routine-type translations. This is an ever-increasing problem, as you are well aware, because the volume of human knowledge is apparently doubling about every 10 years. If we undertake massive translations, you can see once more we are confronted with an explosive problem.

The CHAIRMAN. Yes, sir.

Dr. FLEMING. I have emphasized the training of professional personnel but the Department of Oceanography is only one of many departments in a large university. Because it is located on the main campus, it provides instruction to many more students than our own majors. In most of our undergraduate courses, the oceanography majors are outnumbered by students from other departments of science. In addition, we offer a survey course in oceanography open to nonscientists that this year will be presented to about 900 students. For the past 2 years we have offered a special evening class for schoolteachers and, during the coming summer, with funds from the National Science Foundation, we will conduct a 9-week summer institute for high school teachers. It may interest you to know that for this summer institute we have over 1,100 applications from which to select a group of 30 participants. There is obviously no lack of interest in the science of the sea.

As a department in the college of arts and sciences on the main campus of the university, we cannot lose sight of those educational responsibilities that go far beyond the training of professional oceanographers.

S. 901 contains provisions for the further training of the personnel from various branches of the Federal Government. We have had officers of the Navy, Coast Guard, and Coast and Geodetic Survey assigned to the Department for periods varying from 12 months to 3 years for postgraduate training. Furthermore, we have given special short courses to three groups of officers from the Coast and Geodetic Survey. It is obvious that this type of training is an essential part of the expanded national effort in the marine sciences and that the program should be made available to increased numbers of both civilian and officer personnel.

I have not burdened you with facts and figures. Studies such as those prepared by the Navy, by the National Academy of Sciences, by the American Society of Limnology & Oceanography, and by others, contain estimates of the large numbers of trained personnel that will be needed in the coming decade. Senator Magnuson is to be congratulated on the care with which he has considered the total scope of the expanded effort. It is the intent of the University of Washington to participate in all phases of the marine sciences. Because of the location of the university and because of the importance of the ocean in the economic and cultural life of the State, the university recognizes its great responsibilities in both teaching and research on the ocean and on the marine resources. However, the training of students in oceanography is a national rather than a local problem. An examination of the records of our students reveals that only about one-half of them indicated the State of Washington as their home. About 5 percent are foreign students. Of the graduate students, about 60 percent are from out of State. For this reason, we must depend to a large extent on Federal support if our program is to be increased.

The CHAIRMAN. Most of them leave when they are through because of the shortage throughout the whole country in this field.

Dr. FLEMING. This is true.

In conclusion, I should like to offer the following comments. To effectively implement the comprehensive plans outlined in S. 901, four factors are of the utmost importance:

1. The very highest priority must be assigned to the items relating to education. It takes far longer to train personnel than it does to build ships and other facilities and unless an immediate start is made on the lengthy processes of education, the expanded program will suffer for a lack of qualified staff.

2. An adequate share of the funds for educational purposes must be specifically allocated for the construction or improvement and for equipping of facilities designed primarily for teaching purposes. This will involve grants of considerable size for procurement and construction.

3. An adequate share of the funds for educational purposes must be provided to increase the number of faculty positions. Such funds must be granted for relatively long periods (at least 5 years) in order to attract the high quality of personnel that is desired and also to encourage the faculties to undertake the difficult tasks in basic research.

The CHAIRMAN. We have tried, Doctor, to get away from a real problem in this whole field of science by creating a budgetary climate, an Appropriations Committee climate for, say, the National Science Foundation, to use as an example, so that they won't be limited to a Government fiscal year, from July 1 to June 30, so that they can spread this out and anticipate for 3, 4, or 5 years. The present Appropriations Committee has gone along with me on the National Science Foundation. I hope we can continue that, because these things, as you point out, can't be limited to a July 1 to June 30 basis. It just isn't there.

Dr. FLEMING. This we also feel. I think it is particularly important that any funds that are available for faculty must be for a long period to insure that you not only get the type of scientist that you would like to have, but to give them an opportunity to undertake these long-range research programs that are not really very practical where short-term funds are the sources of support.

4. In formulating plans for the support of students, full consideration must be given to the efficiency in the program as well as to the numbers to be trained. Arrangements should allow students to pur-

sue their studies on a full-time basis, at least during part of their program, and they should permit students wide latitude in their choice of areas of specialization.

The CHAIRMAN. We want to give everybody as much freedom as possible. If the legislation should pass and be signed into law, we hope the decisions on that will be relegated to those who administer the program. They, I am sure, will understand this situation themselves. This is better than Congress or any bureau attempting to straitjacket somebody in this field. That is the general intention of the bill, to give as much freedom as it is possible to give.

Dr. FLEMING. These specific recommendations that I am making, Senator, are not drawn out of a vacuum. In part they are inspired by situations that have existed in the past which I would hope we can improve and correct.

The future security of our country, in the broadest and best sense of the term, rests in the capabilities of our citizens. During a period of explosive scientific and technological change, when the problems of the future cannot be clearly described, investments made in the education of our future scientists are of paramount importance. I am, therefore, very pleased to note the recognition given in the proposed legislation to this aspect and the expanded program in the marine sciences.

The CHAIRMAN. Thank you, Doctor, I appreciate your coming.

RICHARD HOWELL FLEMING

Address: Department of Oceanography, University of Washington, Seattle, Wash.

Major field of interest: Physical oceanography.

Born: Victoria, British Columbia, Canada, September 21, 1909.

Degrees: B.A. (chemistry), University of British Columbia, 1929; M.A. (chemistry), University of British Columbia, 1931; Ph. D. (oceanography), University of California, 1935.

Professional career: Research assistant 1931–36, instructor 1936–41, assistant professor on war leave 1941–46, Scripps Institution of Oceanography, University of California; senior oceanographer 1941–42, chief of oceanographic section 1942–44, administrative assistant to assistant director for research 1944–45, assistant director for research 1945–46, Division of War Research, University of California; Director, Division of Oceanography, U.S. Navy Hydrographic Office 1946–51; executive officer and professor of oceanography, Department of Oceanography. University of Washington, 1951 to date; director, Friday Harbor Laboratories, University of Washington, 1951–58.

Member: Committee on Geophysics and Geography, research and development board; Committee on Atlantic Weather Ships; American Society of Limnology and Oceanography; American Geophysical Union; NAS–NRC Committee on Undersea Warfare, Panel on Environment.

Scientific contributions: Contributions in chemical and physical oceanography; oceanography of the Central American Pacific, the Northeast Pacific, and the Chukchi Sea.

The CHAIRMAN. I want to thank all of you people, particular those of you who came all the way from Seattle on this piece of legislation, because we have had a long and deep interest in the matter. I know that you have contributed a lot to it because there are many other sections of the country that want to draw upon that experience and become a part of this national program that is so much needed.

We will recess, subject to call of the Chair.

Again, thank you all very much for being here.

(Whereupon, at 12:40 p.m. the committee recessed subject to call of the Chair.)

(The following information was subsequently submitted for the record:)

STATEMENT BY WILLIAM J. HARGIS, JR., PH. D., DIRECTOR, VIRGINIA FISHERIES LABORATORY, PROFESSOR AND HEAD, DEPARTMENT OF MARINE SCIENCE, COLLEGE OF WILLIAM AND MARY, GLOUCESTER POINT, VA.

By way of a preliminary statement, which is probably not really needed in this eminent group, I am sure most thoughtful people are aware of the importance of the oceans and their estuaries to society and its economy. At least I am sure they should be.

Some of the ways that the seas impinge on man and his land are—

(1) All, or almost all, the earth's water comes from and goes to the sea.

(2) Much of the earth's soil, with its chemicals, wash into the sea or was once under the sea.

(3) Life originated in the sea and much of the diversity of life evolved and still lives there. In addition, a great deal of this life is useful for food.

(4) Much weather originates over the sea.

(5) Seaborne commerce is vital. It is useful to industry.

(6) Seaborne military weapons are important.

(7) Seashores are extremely important sites for location of communities and industry.

(8) The sea and seashore are very useful as sites for recreation.

It is thus apparent that many depend on the sea at this time. This dependence is increasing. For instance, man will be driven to the sea for more food and water. He will need information to be able to wrest these basic necessities from her.

Despite great present and future needs, man is despoiling the oceans and estuaries at an ever-increasing rate. For example, pollution, e.g., radioactive wastes, industrial wastes, domestic wastes, soil, farm and house pesticides; engineering projects, e.g., dams, channels, marsh fill and draininge; and, overexploitation, e.g., overfishing, excessive water use, are wreaking their havoc. Baldly, bluntly, the future of society depends on man's not ruining the sea. But pressures to do so are increasing as a result of the population explosion and the concomitant industrial explosion. We must not foul the spring from which we will have to drink. We must make wise use of our marine resources. This calls for knowledge—knowledge demands research. Greater research must be carried out. There is urgency for getting this work done because the race to wrest facts from the sea is slow and we fall behind more rapidly all the time. Thus, there is urgency—great urgency.

Because the urgent need for facts demands much additional effort in research, more research people will be needed. This in turn calls for the training of additional scientists.

All of this requires much greater financial support from the Federal Government than is now available. Senate bills 2692 (1960) and 901 (1961) are designed to provide this support.

I thought that S. 2692 was a good bill, I am certain that S. 901 is better. Therefore, I wish to be counted as supporting S. 901 and strongly urging its approval. The bill is well thought out and framed. There are only a few places where emendations should be made if the committee thinks it advisable to do so.

These are—

(1) Page 8, line 3: "six" should be changed to read "eight." This is designed to give a more adequate representation of non-Federal agencies. Also, in this regard perhaps the chairman of this committee should be elected by the committee?

(2) Page 8, line 21: If NSF was intended to contribute significantly to the shipbuilding program, the sum of $9,950,000 is clearly inadequate. As an illustration, a 1,200-ton ship will cost between 5 and 6 million now as against the Woods Hole estimate (1959) of 4.5 million. May I suggest 20 to 25 million for building NSF-supported ships.

(3) The money for maintenance and support of these ships should be revised upward. This is a vital and necessary item in order that the ships will be adequately used.

(4) Page 9, line 3: The sum for shore facilities is probably too small; should be doubled.

As Drs. Revelle, Ewing, and Schaefer stated, the NAS-NRC report "Oceanography 1960–70" was written several years ago. It should serve as a guideline and not a delineator of final figures, because conditions and costs have and will continue to change before the bill is fully implemented 10 or more years from now.

Returning to the proper form of organization to administer these funds, I believe that the present arrangement is a good one. Speaking from a financial point of view, it would, of course, be better to have the committee set up as a strong and independent unit with direct access to the proper financial groups of Congress, but the organization presently proposed probably constitutes a suitable legislative compromise.

It is absolutely vital that the funds needed to implement those phases of the program vested in the individual Federal agencies be appropriated in addition to and not expected to come out of the present budgets of the representative agencies. This applies particularly to the Bureau of Commercial Fisheries which is already very inadequately financed.

It is also vital that the financial support intended for universities and other non-Federal institutions go to those organizations and not be absorbed into the budget of the Federal agency handling the funds. Specific precautions should be set up to prevent such absorption.

One last general comment. It should be explicitly ascertained that marine biology will be adequately supported. It is an extremely difficult discipline with problems that are generally tougher, perhaps as much as three times more difficult, to solve with precision than those in the purely physical realms. If this assumption is correct, it would seem to follow that a large portion, perhaps as much as 55 to 65 percent of future scientific effort, should go into biological research. This is not the usual ratio, however; usually the physical sciences are much more heavily financed.

To this point, all we are primarily interested in is how the physical phenomena affect plants and animals, including man and society. Therefore, it would seem doubly necessary to have the biological aspects more realistically supported. Biological oceanography must be adequately supported.

In closing this statement, I would like to reiterate my firm support of S. 901. It must be implemented.

WOODS HOLE OCEANOGRAPHIC INSTITUTION,
OFFICE OF THE DIRECTOR,
Woods Hole, Mass., April 4, 1961.

HON. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: I appreciate most sincerely your kind invitation to comment on S. 901 which you introduced during the current session of the 87th Congress. Regrettably, the invitation to appear at the hearing was received while I was on extensive travel from which I did not return in time to permit me to be in Washington during the hearings. Needless to say, those of us in charge of oceanographic institutions in this country have a vital interest in the proposed legislation and have thought a great deal about its impact on marine sciences.

The congressional interest in oceanography during the past 2 years is most encouraging and the influence of the introduction and passage by the Senate of your bill S. 2692 during the 86th Congress has already been evident. The report of the National Academy of Sciences and the Navy's TENOC plans, together with Senate Resolution 136 adopted by the 86th Congress, reflect the intensive study and careful collaboration of distinguished scientists, Government leaders and legislators. The implementation of these carefully considered programs is essential for their potential benefit to mankind and is mandatory to our national security. Therefore, my comments should in no way be interpreted as evidencing other than pleasure and satisfaction that your committee has studied with such care these recommendations for marine science, and that the drafting of S. 901 has resulted in such thoughtful enunciation of policy.

Repeatedly, this proposed legislation has emphasized the need for substantial expansion of basic research. Our knowledge of the oceans and the phenomena which occur within them is still relatively primitive compared to the other geophysical sciences. Additions to our knowledge of the oceans will come primarily from basic research in which the investigator is seeking to discover new facts without immediate concern as to the ways in which these facts may be used. It is certain that new knowledge growing out of the program itself will furnish the basis for changes in emphasis and that new discoveries will require the inclusion of wholly new kinds of activities. Careful avoidance of restrictions that might impede the flexible growth of a long-range program is very important in such enabling legislation. Whereas I appreciate the importance, as you noted in your personal letter to me a year ago, of Congress being specific in defining any new program, it is essential also that the legislation be specific in encompassing the future unknowns that basic research will uncover. In this manner, those who interpret the law in years to come will have no doubt that instruments, ideas or resources undreamed of today are equally well covered with those now spelled out in such excellent detail.

The expansion of S. 901 over the bill introduced at the last session of Congress indicates in a gratifying way that many of the comments of oceanographers were recognized and heard. The additions in the field of education and the inclusion of other agencies is particularly welcome; however, the fact that so many felt the need for specific additions points up the hazard of spelling out the program in this detailed manner. Specifically, I would suggest that there be repeated in the beginning and end of the bill a statement that the proposed program is minimal and that expansion, modification, and change will be necessary. I realize that such wording is already included but too often legislation is taken to be restrictive rather than permissive in its interpretation.

Oceanography is a complex science; it embraces all the physical and biological sciences just as the oceans embrace the earth. Therefore, it is obviously wise to recognize the need for interagency cooperation in order to achieve the goal set forth in the declaration of policy as stated in this bill. However, I am concerned with the specific proposals relating to the establishment of a Division of Marine Science within the National Science Foundation. Certainly the National Science Foundation has adequately demonstrated its ability to properly foster basic research and it would be most appropriate for the Foundation to have a key role in the expanding program of oceanography, even to a larger extent than proposed in S. 901. However, it is not so clear to me that the Science Foundation should be put in the position of interagency coordinator or that a fixed membership of a divisional committee as proposed is wise. In fact, the nine Government bureaus identified for furnishing members of the division committee may be forced to name individuals with little or no experience in marine sciences, or perhaps no contact with research at all. This is entirely different from other divisional committees of the National Science Foundation. There is no question but that Government agencies should be represented on National Science Foundation committees wherein the members are chosen because of their scientific ability in the particular field, rather than solely to speak as representatives of their particular bureaus. The past success of the Foundation rests largely on its freedom to name outstanding scientists to their committees and management levels. I would strongly recommend that if a Division of Marine Science is established within the Science Foundation that the present pattern of giving the Foundation complete freedom in selecting the members for the divisional committee be afforded them.

Finally, I should like to note with pleasure the specific notation that the research ships to be constructed by the Maritime Administration are in addition to those authorized for the other agencies. The continuation of funding of research vessels in the manner of the National Science Foundation grant to this Institution is imperative to the continuation of the private institutions now doing basic research in oceanography. In this connection, an aspect which so far has not received sufficient attention and which needs to be funded in like manner is for shore facilities. Our future in marine sciences will inevitably rest like a three-legged stool on ships, shore facilities, and trained scientists, each of which is essential for progress and each of which must be supported in a balanced program.

In conclusion, may I express again my gratitude for the opportunity to submit these views and to express our great satisfaction at the interest which you and your associates have taken in the science which is the complete mission of our Institution here in Woods Hole. I hope it will be possible for you, members of your committee and your staff, to visit Woods Hole and to see firsthand some of the research we now have underway. As an illustration of this, I am sending you a copy of our recently published "Atlantic Ocean Atlas."

Sincerely yours,

PAUL M. FYE.

STATEMENT BY DR. PHILIP HELFRICK, ACTING DIRECTOR, HAWAII MARINE LABORATORY, UNIVERSITY OF HAWAII, HONOLULU, HAWAII

Re medical and pharmacological implications of expanded research on toxic marine organisms as provided for in S. 901, subsections (b), (c), and (d), section 9, and subsections (b) and (c), section 10.

It has long been known that the waters around islands of the tropical Pacific harbor many species of fish and invertebrates that are toxic when eaten. Some of these toxic forms have been the subject of scientific investigation, others have seldom or never been reported in the scientific literature.

Very little is known about toxins harbored by marine invertebrates. However, during the last 20 years some studies have been made on three groups of toxic fishes. Both the puffer fishes, which bear an endogenous toxin, and the scombroid fishes, which are toxic due to the rapid action of a bacterium, have been studied. A third group of fishes, representing many different families, carry a toxin that causes a widespread disease known as ciguatera. This condition is presently the subject of a limited study by a group of scientists at the Hawaii Marine Laboratory.

The presence of the many species of fish bearing ciguatera toxin causes a major health problem in the tropical Pacific, both to the native residents and to sojourners. To the natives, the loss of part of the food resources of the sea, their principal source of dietary protein, causes an acute nutritional problem in addition to the threat of sickness or death. To the sojourners, especially to the military on the widespread bases, the presence of these toxic species, especially such normally edible species as red snappers and pompanos or jacks, presents a grave and recurrent medical problem.

The toxin producing ciguatera was selected as the primary focus of the initial studies on marine toxins at the Hawaii Marine Laboratory. This disease may be produced by eating certain of the species of marine fishes from an affected area. These toxic fish, upon being eaten, will cause a variety of symptoms ranging from an initial gastrointestinal disorder to acute neurological symptoms involving both skin sensation and motor reflexes; acute cases will result in temporary paralysis or even death.

Because there is no known antidote for the treatment of ciguatera, and symptomatic treatment is of variable effectiveness, attention has recently been turned to the pharmacology of ciguatera toxin in order to learn more of its mode of action and thus to develop a more effective medical treatment for the disease. In addition to treatment of the disease, knowledge of the pharmacology of such a biologically active agent as ciguatera toxin might well lead to its controlled use in the treatment of other human maladies.

Numerous other tropical marine organisms are known, on occasion, to cause sickness when ingested by humans. These include certain mullet, sardines, sharks, turtles, shore crabs, octopus, and other organisms that are potential sources of food from the marine environment. Very little is known of the biology of most of these organisms or the toxicology of the poisons they may contain. Pharmacological investigations of such toxins that would reveal their mode of action would aid in treatment of affliction resulting from their ingestion. It may also reveal properties that might prove valuable as drugs for other purposes.

The little explored marine environment offers great promise as a source of biologically active agents with potential as drugs for the treatment of the disease. For example, preliminary exploratory research has revealed that certain fishes found in the Pacific seasonally contain a substance that causes hallucinations in humans. A thorough knowledge of the pharmacology of such a substance might yield a drug useful in the treatment of certain nervous disorders.

In the past, research relating to the discovery and determination of medically and pharmacologically important substances from marine organisms has been restricted by limitations of funds, facilities, and to some extent the availability of trained personnel. Senate bill 901 as proposed, particularly sections 9 and 10 would greatly encourage and facilitate such research.

STATEMENT BY DR. WAYNE V. BURT, CHAIRMAN, DEPARTMENT OF OCEANOGRAPHY, OREGON STATE COLLEGE, CORVALLIS, OREG.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

SIR: A copy of your new bill on marine sciences, S. 901, was received from your office several days ago and I have been studying it in detail with much pleasure. I am impressed with your understanding of the urgent need for expanded Federal support for private and State oceanographic institutions as well as Federal organizations already operating in the field. This bill is a comprehensive piece of legislation that is consistent with this broad necessity. In addition, it is specific in its analysis of the problems involved and positive in selection of actions to be taken. I wish you success in attaining passage by the U.S. Senate.

As you know, the importance of both basic and applied research in oceanography has only been generally comprehended recently. The true needs have only been known by a few men working in Federal, State, and private organizations with definite missions in or on the oceans. Fortunately, during the years since World War II, oceanography has attracted and held a number of exceptionally able and devoted scientists. Recent strides in pure discovery, in ingenious application of electronic and sonic techniques, and in international cooperation are striking. Within the past 10 years two strong ocean currents have been discovered and mapped, where they had not been previously known to exist. Underwater television and free diving vehicles have become almost everyday tools; sonic devices have been improved until we can see individual fish many yards below a ship. Exchange of data and ideas has greatly increased principally due to IGY.

Now the oceanography discipline finds itself with a good strong program in its inception but with a need for more tools with which to work. Your bill would adequately furnish support for these tools (ships, laboratories, instruments, and operating funds).

As chairman of a federally supported university department of oceanography, I feel that we have two primary responsibilities. One is to carry on free basic research in oceanography which appeals to our researchers. This will lead to new basic facts about the oceans with ultimate applied uses. The second responsibility is to interest, and to educate young men and women who have the scientific potential to become the oceanographers needed for both pure and applied research. Only in this way will the great pool of intelligence in our young people throughout the country contribute the stimulated (and stimulating) young minds this scientific field must have to prosper. Our colleagues in the Government laboratories have told us repeatedly they need these trained personnel most urgently and that they look to us to provide them.

To accomplish this task, we need the help of the U.S. Senate and the House of Representatives. We need encouragement and support both of university teaching and research, and of the programs of the Government laboratories and institutions, since the field must grow in a well-rounded way.

A university's first task is to attract and maintain a staff of able and energetic scientists who are devoted to teaching and are also experienced in research. Oceanography is still, to a great extent, an empirical science where active research must be pursued side by side with teaching programs to give the student a full understanding of the field. Nuclei of faculty are now actively at work at over a dozen institutions of higher learning around the coasts of the United States and near the Great Lakes. Most of these institutions need grant-supported faculty members to meet the rising demand for instructors and senior researchers. A good start has been made. The university and laboratory staffs will grow, if the present training program is supported and expanded through grants as provided for in your bill.

A second consideration is the need for tools for research. These are ships, instruments, and shore laboratories. All State and private oceanographic laboratories are desperately crowded for research space. The U.S. Navy and other Federal agencies have generously provided ships for conversion for use as oceanographic vessels whenever possible, but naval officials have been among the first to realize our difficulties in using converted ships for purposes for which they were never intended. Special ships are urgently needed by virtually all of the seagoing facilities, Government and private institutions alike.

At Oregon State University, we have been especially fortunate to receive assistance from both the U.S. Navy, through the Office of Naval Research, and the National Science Foundation, for construction and equipment of a small, seagoing vessel, the RV *Acona*. (Its 154 tons make it about one-thirtieth the size of modern Russian research ships.) We have just begun sea trials on this vessel, so cannot report to you on the merits of the special design features we were able to incorporate. However, I recall your attention to this vessel because I believe the impact is great on the thinking of the people in the Northwest, and that many of the students who come to us now, and to our sister institutions of the west coast, have been made aware of the importance the Government attaches to oceanography by the very fact of support for construction of the vessel. Furthermore, the *Acona* is now a new, equipped seagoing laboratory for conjunctive training and research.

With the *Acona* we are initiating an intensive study of the biological, physical, geological, and chemical properties of sea water off the Oregon coast. Unbelievably, this work has never been done. If fishermen ask us about currents offshore, or if the Navy requires information on sound transmission and surface or subsurface operating conditions, there are almost no data from which intelligent answers can be framed. It may be hard for many Americans to believe that, or at least to understand why, portions of the coast of this country are so little known. It is not due to lack of interest or ability of agencies entrusted with coastal exploration, but simply to the magnitude of the task.

Here in the Northwest, weather fit for oceanographic research is rare and until we had locally based vessels, adequate surveys had been too dangerous and expensive to undertake.

In these days of nuclear submarines, however, the work cannot end at the continental slope. Thorough exploration of all oceans is essential; detailed studies of all physical and chemical processes in the sea must be undertaken by every means suggested by imagination: an obvious necessity is for the larger, more capable ships for all laboratories.

The Department of Oceanography of the University of Washington has done a heroic job in trying to survey an important ocean area several times the size of the United States with a small wooden 300-ton, 26-year-old converted Government vessel.

The observations must be made at sea but most analysis must be done ashore. Laboratories are desperately needed to allow our research men to collate their data, to pretest equipment before expensive searuns, to work out their hypotheses and to design their experiments. An oceanographic laboratory must be a surprisingly varied place. It must have sea-water tanks for display of, and experimentation with, marine organisms. It needs a large elevator to transport geological cores, cases of electronic equipment, and even small skiffs used as anchored buoys and crammed with sensitive equipment. It needs a machine shop, at least one large electronics laboratory, and several wet labs for chemical and biological assays. It requires extensive and intensively planned electrical power supplies to operate centrifuges, photometric devices, counters, printouts, and pressure chambers. It must have blackboards and light tables and above all private offices where a researcher can think without the clatter of machines and conversation to distract him.

Such buildings are not found in every city or even on every university campus; they must be specially designed and constructed.

I have not discussed the many problems of instrumentation, and I hesitate to do so since this letter has already become quite long. We are pleased to observe growing up around the country a number of oceanographic instrument manufacturers, or oceanographic instrument divisions in firms well established on other bases. We urge encouragement of this type of endeavor—oceanographers have long had to "make do" with poor equipment made on the spot, usually by the investigator himself.

This letter is in no means meant as a criticism of any of the Federal agencies who are presently either doing oceanographic research themselves or supporting research at private institutions or State laboratories. On the contrary these agencies are to be commended on their continued support of the field. The Geophysics Branch of the Office of Naval Research and the Earth Sciences Branch of the National Science Foundation are to be particularly commended on their constant effort to obtain full value from the funds entrusted to them to support oceanographic research outside the Federal Government.

Finally, Senator, I would like to thank you again for your keen study into the problems of this science. Anyone acquainted with the field sees in this bill a level of high effort devoted to patient work, and to discussion with "experts" of various pursuits, and can discern the real intent to fulfill the best interest of the country and of the science. It is a bill I am proud to support, and one which I am eager to commend to the full consideration of your colleagues in the U.S. Senate.

Very truly yours,

WAYNE V. BURT,
Chairman, Department of Oceanography.

STATEMENT BY DR. HARRY SOBOTKA, DIRECTOR, DEPARTMENT OF CHEMISTRY, THE MOUNT SINAI HOSPITAL, NEW YORK, N.Y.

The undersigned, Harry Hermann Sobotka, Ph. D. (Munich), has been research fellow at the Rockefeller Institute for Medical Research, 1924–26; research associate at New York University, 1926–28; and director of Department of Chemistry at the Mount Sinai Hospital, New York, since 1928.

My scientific work in the field of organic and biological chemistry has included numerous marine biological investigations. As far back as 1936 in the introduction to one of my books, I predicted the development of a new branch of biochemistry, namely comparative biochemistry, that is the study of the composition and metabolism of all known living beings. At that time, the knowledge of the chemical metabolism of animals was based on and confined to observations in man, dog, cat, rabbit, rat, mouse, the proverbial guinea pig, and with a few scattered frogs, horseshoe crabs, and sea urchins thrown in for good measure. The prediction that the remaining hundreds of thousands of animal species will become the subject of biochemical investigation has been borne out fully during the last 25 years. Within the domain of animal chemistry, the study of the fauna of oceans and lakes plays an important role because of their infinite variety.

I have myself participated in this development and my investigations in this field have been greatly facilitated by various marine biological laboratories both on the Atlantic and Pacific coasts, the American Museum of Natural History, and by the collaboration of colleagues in marine biology.

As an instructive example, I should like to mention the study of a poisonous principle, occurring in a Caribbean sea cucumber, not a plant, but a cucumber-shaped animal related to the starfish. We have isolated the poison from the poison gland of these animals and have named it holothurin. Amongst the interesting properties of this compound, I wish to mention the three following:

1. Holothurin is a terrific poison for fish and will kill them rapidly, even when diluted 5 million times. The sites where they are found are therefore, not surprisingly, poor in animal life.

2. A similar poison has been found in starfish and appears to be involved in the ravages caused by starfish in the oyster beds along the Atlantic coast.

3. Holothurin has been injected into rats carrying experimental tumors. If the amounts of the poison are kept below the dose that would kill the rat, it exerts a definite cancerolytic effect, that is it stops the growth of the cancer and even makes it vanish. Since holothurin is still too toxic for the use in therapy of cancer, we are at present engaged in unraveling its exact molecular structure. This will enable us to produce synthetic drugs of similar constitution to be tried in the chemotherapy of cancer.

I have given these three examples to illustrate what I consider to be three of the most important applications of marine biology and therefore, three of the most cogent reasons for the prompt enactment of the Marine Sciences and Research Act.

1. The poisonous action of holothurin has suggested to the Navy its use as a shark repellent. This is just one of the innumerable applications of marine biology to the use by the Armed Forces, and thus to the security of our country.
2. The knowledge of the chemical weapons used by the enemies of our food supply will be of great importance to our fisheries. A little reflection renders it obvious that the food requirements of our ever increasing population will have to rely in increasing measure upon the products of the ocean.
3. The study of the chemistry of marine life will contribute to the physician's arsenal in the fight against cancer and other disease.

It should be emphasized that marine biology deals with plants as well as with animals. While bigger fish eat smaller fish, this does not go on ad infinitum, but smaller animals feed on the rich flora of the oceans. Besides, being the ultimate source of energy of all life, animal as well as plant, the marine plants have many other properties capable of important practical application, including noxious effects like fish killing "red tides" in the Gulf Stream which must be studied to be eliminated.

To summarize, construction and provision of substantially enlarged facilities for marine science and research constitutes a vital and urgent need for national security and the vital issues of food supply and public health. Evidently, these needs can no longer be met to a satisfactory extent from private sources and require congressional appropriations beyond existing incidental support by the Office of Naval Research, National Science Foundation, etc. The Senate bill S. 901 adequately fills this gap in well organized form. I strongly urge its passage by Congress.

STATEMENT BY THE FACULTY OF THE COLLEGE OF FISHERIES, UNIVERSITY OF WASHINGTON, SEATTLE, WASH.

Over 70 percent of the surface of the world is covered with water and these waters represent the world's only major unexploited source of protein food. This food is now urgently needed in countries where the people have a diet deficient in proteins. In addition, the oceans will assume an important role as a potential source of food for the large populations that are expected in the future.

The present utilization of the resources of the sea represents only an insignificant fraction of its potential. Relatively few species of fish and shellfish are exploited but while some of these are being overexploited, the untouched potential which exists includes undetermined quantities of traditional foodstuffs, such as fish and shellfish, as well as large stocks of other organic materials such as phytoplankton and zooplankton. Because of our very limited understanding of the relationship of fish populations to food organisms and the chemical and biological cycles in the sea, it is doubtful that we are utilizing to the best advantage even those stocks which are harvested.

At present the United States is not in a position of want and there seems no likelihood of change in this condition in the foreseeable future. This is expressed officially in the little interest our country shows in fisheries and in fishing and in our relatively low per capita consumption of fish and shellfish. It is significant that the per capita consumption of fish in the United States has remained the same for some 30 years during which our total consumption of fish has increased only in proportion to our population. However, during the last 20 years the total production of marine foods by U.S. fishermen has not increased, so that the increasing consumption of fish is being supplied by imports. While this may not be viewed as a disadvantage by those interested in promoting imports from other countries, there is some question as to the wisdom of permitting this country to develop a dependency upon foreign sources for foods which can be supplied from our own waters by our own fishermen.

Some problems typical of those that will arise if this country does not develop a better knowledge of the potential fish supplies are now presented by the rapid growth of the fishing fleets of Soviet Russia. Russia has added to its fleet the largest and most modern fishing and factory vessels in existence. Recent reports indicate that over 160 vessels are operating on the Grand Banks off the east coast of Canada. Another large fleet of fishing and processing vessels is operating in the Bering Sea. Still more recent reports indicate the presence of well-equipped Russian fisheries research vessels in the Gulf of Alaska. Russia has expanded her fleets as a part of an announced plan to increase fixed fish production by about 250,000 tons annually during the next several years. A major part of her long-range plan is further expansion of her high seas fleets in other areas of the world.

These large fishing fleets that are being developed by Russia along both coasts of North America should not be viewed lightly. At the very least, as they grow in size they can threaten the stability and the productivity of the fish stocks along our coast. Without a major intensification of biological research on these fish stocks we will have no basis for measuring the effect of this intensive fishing.

We are not equipped to intensify our research without a major increase in oceanographic vessels and of funds for oceanographic programs. Whereas the Russians and the Japanese have large fleets of fishing vessels operating in the Bering Sea and have a number of research vessels assigned to work continuously with these fleets, the United States has only one high seas fisheries research vessel which is assigned year around to the northeast Pacific. This vessel, the *John N. Cobb*, is relatively small and is primarily engaged in exploratory fishing. It is limited in its range and is not capable of carrying on all of the work that is necessary. Other vessels which have been chartered for special research jobs, especially in connection with the work of the U.S. section of the International North Pacific Fisheries Commission are modified fishing vessels. Such adapted vessels are not satisfactory for research in oceanography and experience has proved that they are no more satisfactory for research in fisheries biology.

A major question that should be considered is whether or not the recent accelerated growth of the Russian fishing fleets indicates a move to control the marine fisheries of the world. It is not essential for the Russian fishing fleets to make a profit, so that they can build very large boats with the most modern and expensive equipment and still compete with any other nation. If this control is their objective, other countries such as Japan which are largely dependent upon fish could well be forced to reassess their world relationships.

In our administration of fisheries, we have maintained that they are a common property resource so that fish are not subject to ownership except when reduced to possession. With the failure of the last Conference on the Law of the Sea to define "international fisheries ownership" any better than this, or to reach agreement on territorial limits, the only hope of protecting any of the marine stocks now lies in the development of treaties between nations. However, without general agreement among nations concerning responsibility for maintaining the productivity of the world's fish populations, any nation which is not a party to a conservation treaty would not be bound by its provisions. Our marine fisheries therefore have no real protection against the operations of any country that might wish to exploit them either for its own benefit or for political purposes.

Fishing, therefore, represents an enterprise of high risk which must promise a quick return on capital investment to be attractive, especially to the individual investors who now dominate American fisheries. Such an industry is especially sensitive to competition when it appears in the form of greater resources in capital which permit development of expensive innovations in techniques, or as a low-cost labor which permits lower production costs regardless of efficiency. The Russian fisheries are backed by their national treasury which is now providing the most modern equipment for harvesting fish and whatever funds are required for research. The Japanese fishermen operate at a small fraction of the wages demanded by U.S. fishermen and through large fishing companies which maintain stability by a wide diversity of interests. Of U.S. fisheries, only the Pacific tuna fishery presently maintains a competitive advantage over foreign rivals through the recent and rapid adoption of the power block and nylon purse seiner. Whether this advantage will survive adoption of equally efficient gear by other nations is uncertain. There is no question that technological problems raised by this new method of fishing tuna will have to be solved to prevent loss of competitive advantage through excessive spoilage of product.

The lack of new investment in most of our fisheries is reflected in outmoded vessels, retention of old methods of fishing as well as in a retarded technology of handling and processing. The inertia which has grown out of economic competition with what appears to be more favored foreign fisheries, well supported by their governments, has been increased by complicated restrictive laws in many fisheries, designed by conservation agencies to meet the needs of conservation while attempting to recognize, at the same time, the right of every man to share in any fishery, i.e., to maintain the concept of a "common property resource."

Covering over 70 percent of the surface of the globe, the tremendous potential of the oceans as a source of food, as a source of minerals and as a means of worldwide communication cannot be ignored by the United States. Nor can the Federal Government leave responsibility of development of the required knowledge concerning the oceans to individual States with their limited ranges of jurisdiction, interests, and resources.

The United States cannot afford to surrender control of the fisheries off its coast to Soviet Russia or to any other country, first because of the potential direct threat of the presence of large fleets of foreign fishing vessels off our coast, as well as from the aspect of world production of food. Further, it must be recognized that control of marine fisheries can be used by Russia to exert economic or political pressures on any country which is dependent upon marine fisheries.

Senate bill 901 recognizes the need for the United States to study the ocean and its fisheries. It is especially important in that it provides for the study of the economic and technological, as well as the biological aspects of the fisheries. With specific allocation of at least 25 percent of the funds indicated in section 6 for grants to universities for basic fisheries research it will provide support for the training of graduate students in fisheries biology and technology. Well trained scientists in these areas are now scarce in the United States and are an absolute requirement for the developments provided in the bill and are also needed for continuation of present fisheries programs.

It is a pleasure to support this bill and to express the interest of the faculty of the College of Fisheries in its passage.

COLLEGE OF FISHERIES' FACULTY

Mr. Milo C. Bell
Dr. Allan C. DeLacy
Dr. Alexander M. Dollar
Dr. Lauren Donaldson
Dr. Paul E. Fields
Dr. John Liston
Dr. William F. Royce
Dr. Albert K. Sparks
Dr. Richard Van Cleve
Dr. Arthur Welander

Statement by Dr. Carl H. Oppenheimer, Marine Microbiologist, Institute of Marine Science, Port Aransas, Tex.

March 8, 1961.

Hon. Warren G. Magnuson
U.S. Senate, Washington, D.C.

Dear Senator Magnuson: I appreciate the opportunity to present to your committee my views, and I hope those of my esteemed colleagues, on the important but usually under-emphasized field of marine microbiology as part of the general topic of oceanology and the need for an intensification of effort to provide an understanding of the field.

May I commend you and your colleagues for the broadness of bill S. 901, the prospective Marine Science and Research Act of 1961. It is not my intent to delve into any specific aspect, but rather it is my desire to emphasize the position of the field of marine microbiology in the plan of oceanographic development and how your bill will stimulate research and teaching in this important aspect of science.

The rather few scientists in our field cannot begin to cope with the important aspects of our field which need immediate attention. Our expanding population daily introduces new aspects of marine microbiology which cry for understanding and possible control. Deep sea microbiology is almost nonexistent in the United States, and the only major effort in this field is being made by Russia, who has five large oceanographic research ships with microbiological laboratories and attendant scientists. Before one can fully understand the role of micro-organisms in the sea, he must have a general background in oceanology. An increase in the training and research facilities of marine laboratories, the establishment of new laboratories, and above all, the establishment of research fellowships, would provide the necessary centers and impetus for the training of the marine microbiologists who are currently needed. We must turn more and more to the seas for water, food, and raw materials. It takes time for microbiological research, and therefore bill S. 901 is quite timely in that it provides the impetus to start now on research to alleviate existing problems and those which are imminent.

Microbes are important to almost all fields of oceanology: environmental health, including pollution, health hazards by toxic byproducts of metabolism or by direct disease production, radioactive uptake, production of surface active agents which enhance the wind distribution of toxic material from wave tops, causative agent of fish diseases both in the natural sea and in the marine aquaria; deterioration of manmade products such as cordage, wood, rubber, plastics, concrete, iron corrosion, fish and shellfish deterioration, destruction of instruments; geochemical activities of importance to the understanding of the past history of the earth and especially the petroleum; the use of microbes to trace currents or water masses; and in their role in all the cycles of nutrients which are necessary for life to continue in the seas.

Of course, these aspects of microbial activity are a direct or indirect result of the natural process of reproducing themselves. These properties, or results, of growth and reproduction imposed on the environment are the important aspects for which basic study and information is needed which can be applied to the control of the activities. Two of the most important aspects are photosynthesis and the decomposition of the remains of other living organisms. Life could not continue without these two processes by which energy from the sun is used to convert inorganic materials into protoplasm and the decomposition of the protoplasm back to the elements for the process to cycle through the ages. We need to know more about the speed of these two processes and how they are changed by environment and other factors.

Generally speaking, micro-organisms found in marine environments are bacteria, fungi, viruses, unicellular algae, and protozoans. These small organisms have one property in common: they are unicellular, and within a size range as to be affected somewhat similarly by the physicochemical aspects of the environment.

There is considerable controversy over the existence of true marine micro-organisms. Very little is known about the effects of salts in sea water on the small organisms and especially metabolism and transport of food through membranes. It may well be that the only difference between a marine micro-organism and a terrestrial micro-organism is that the former is more efficient energetically and can thus compensate for the osmotic effects of the salts on the cell. When bacteria and other unicellular forms are washed from land into the sea, they immediately encounter the osmotic forces due to an increase in salinity. Some micro-organisms, notably the pathogenic types, are killed within a few days or months. The micro-organism which survives may be classified as a marine bacterium.

Micro-organisms have been found in almost all natural samples of sea water and sediment which have been analyzed. The distribution of micro-organisms appears to be sporadic following hydrographic features and the presence of available nutrients. Generally more bacteria are found near land, and especially where the bottom sediments are stirred up. Sediments contain up in the millions of bacteria per gram and usually more than the overlying water. Thus, upwelling, waves, and storms may move the bacteria into the water. The open ocean usually contains fewer micro-organisms. Although only 7 percent of the total oceanic area is less than 200 meters deep, it is estimated that the attendant microbial activity exceeds the remaining 93 percent of area.

As a closing example of the need for expansion of basic and applied research in this field, I should like to refer to two serious problems which need more attention than they are now getting. It must be emphasized that these are only two of many such problems confronting us at the present time.

One is the problem of the gradual buildup of detergents within our natural water systems. The highly effective cleaning detergents of the housewife are usually not broken down by sewage treatment, and the sewage effluents contain residual detergents. Most of the water passing down the rivers to the oceans is reworked several times through local metropolitan water systems. The British have already felt the impact of detergent buildup in recycled waters as evidenced by the frothing and by the fish killed in the rivers of highly populated England. These detergents, at a concentration of a few parts per million, are toxic to fishes and aquatic life. At the present our marine waters probably do not have an effective detergent concentration, but who has suspected that perhaps the detergent content of the waters of the Chesapeake Bay and other similar areas might be significant in the decline of the oyster populations? What do we need to do to combat this? One possible way is to create effective detergents which are easily broken down by marine organisms after their cleaning job is done, or to make, by mutation, bacteria which decompose the existing detergents.

The second problem is that of finding a suitable criteria for pollution assay. The time honored method of coliform or *E. coli* determination certainly falls short of being an accurate sewage indicator in the marine environment. There are some scientists working in this area at the present time, but it is obvious that intensified research will be needed before the problem is overcome.

In every attempt to describe a science it is necessary to oversimplify for the sake of clarity of the entire picture. This has been attempted in the foregoing paragraphs. We must face the fact that the marine microbe is important to our very existence. It is hope that this simplified picture of the importance of the marine microbe will be of value in your posing problems of establishing a program of marine research and teaching with respect to the future of the people of the United States and of the world.

Very truly yours,

CARL H. OPPENHEIMER,
Marine Microbiologist.

BROOKLYN INSTITUTE OF ARTS AND SCIENCES,
KITCHAWAN RESEARCH LABORATORY, OF THE
BROOKLYN BOTANIC GARDEN,
Ossining, N.Y., December 22, 1960.

Senator WARREN G. MAGNUSON,
Old Senate Office Building, Washington, D.C.
(Attention of Mr. Daniel B. Markel).

DEAR SIR: We are very much interested in the proposed Marine Sciences and Research Act which passed the Senate, and hope that with amplification and renewed backing, this kind of a bill will be voted through in the next Congress.

Our interests here in Kitchawan in marine biology center around basic problems in physiology and ecology of plants and microbes in the sea, and their relations to nutrition of animal life in the ocean. For many years we have worked with antibiotics in land organisms and only recently have we turned to potential medicinal substances produced by marine forms of life. We published a note recently on antibiotics in corals, and have a paper in press in Botanica Marina dealing with antibiotics in numerous seaweeds of Puerto Rico. Dr. Sieburth and I studied the antibiotic plankton in Antarctica, and he has published a paper in Science, showing that acrylic acid is an antibiotic in the yellow-green alga, *Phaeocystis*, growing abundantly in Antarctic waters. This marine antibiotic, eaten by penguins for thousands of years, may have important uses as an additive in poultry feeds. It now appears that the ocean contains a large number of growth inhibitory substances, including antibiotics and poisons, that need to be studied for the sake of knowledge and applications to human welfare.

Some of our other marine studies have been concerned with productivity of organic matter and its turnover in various microbial processes and its availability to marine animals. At the present time we are studying the vitamin relationships among thousands of cultures of marine bacteria and many small marine algae that carry on photosynthesis and other kinds of synthesis. A report of 101 pages on marine microbiology has just been sent to the Office of Naval Research, Washington, D.C., covering work done by us on an ONR contract this past year. That report would be available to you through the Office of Dr. C. D. Cox, Head Office of Microbiology Branch, ONR, Washington 25, D.C.

Currently we are working on diverse kinds of marine bacteria that require or produce vitamins B_1, biotin, and B_{12}. Methods are being further developed for assaying B vitamins in sea water and various marine materials. We are also trying to assess the value of bacteria as potential transformers of low-value protein to proteins with high biological value for fish life.

A few of our reprints that are available are enclosed for your information.

May I further point out to you that the marine biologists in our country need a good tropical station for marine science, particularly for researches in tropical marine biology. There is a beginning of such a station in Puerto Rico, where the University of Puerto Rico has maintained a place for their students and visiting scientists for several years. At the suggestion of Vice Chancellor Luis Stefani, University of Puerto Rico, I prepared a little statement about an expanding program in marine science in Puerto Rico, where cooperative researches can be carried on by local people and visitors from all nations. There are magnificent coral reefs and rich mangrove-fringed bays in the shallow waters of Puerto Rico. We have proposed to Governor Muñoz-Marín and our National Park Service that selected areas should be organized into a tropical marine park for the purpose of conserving the scientific resources and natural beauty of the maritime region. A carbon copy of the proposed marine science project is enclosed.

May I point out something related to our present thinking, that may transcend in importance the role of marine science in the future welfare of mankind. The oceanic isle of Puerto Rico is the world's showcase for democracy. Perhaps one of the best pieces on display could be a fine group of marine scientists working together in an atmosphere of freedom in Puerto Rico that still belongs to the Western World.

I shall be pleased to do anything further to assist you in your efforts for science and human welfare.

Sincerely yours,

PAUL R. BURKHOLDER,
Director of Research.

STATEMENT BY DR. PAUL R. BURKHOLDER, DIRECTOR OF RESEARCH, KITCHAWAN RESEARCH LABORATORY OF THE BROOKLYN BOTANIC GARDEN, OSSINING, N.Y.

The potentialities of expanded research in marine biology for applications in medicine and pharmacology are very promising. Our current investigations indicate the occurrence of antibiotic properties in the marine plankton of different geographic areas, as well as in many seaweeds and corals, and among numerous bacteria of ocean sediments. Many other investigators have reported various poisons, physiologically active agents, and rare chemicals in plants and animals of the sea. The real significance of marine biology to mankind in the future will only become known through fundamental studies with all kinds of sea life, their kinds, their functions, and their products. It is believed that S. 901 will provide the means for training technical personnel and carrying on effective researches in marine biology and in other phases of oceanology that will be important in the future.

STATEMENT BY DR. DALE F. LEIPPER, HEAD DEPARTMENT OF OCEANOGRAPHY AND METEOROLOGY, AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS, COLLEGE STATION, TEX.

MARCH 23, 1961.

HON. WARREN G. MAGNUSON,
Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

MY DEAR MR. MAGNUSON: Thank you for the invitation to comment upon your Marine Sciences and Research Act of 1961. I have just reread it and I was again amazed at the thoroughness with which you have laid out a plan of action.

The bill as it now stands is a considerable improvement over that of last year, in my opinion. You have pulled together many straggling programs and fitted them into a clear pattern.

You may recall that I wrote you last year under date of January 6, 1960, concerning the matter of international data exchange through the world data centers established for the IGY. World Data Center A is here at Texas A. & M. College. This center has growing international recognition as indicated for example in a resolution from the January 24, 1961 meeting of the International Geophysics Committee. There appears to be a strong continuing need for a university based, nongovernmental, nonmilitary data center in oceanography. The United States should not lose the advantage which it now has in having one of the two such centers established under successful international agreements. I assume the wording of your bill would permit the continued support of this center so that no modifications are needed.

I have no additional comments upon the bill. Regardless of its fate in Congress it has already done a remarkable amount of good for the marine sciences in the United States by bringing so much attention to them. In an intelligent way it has demonstrated the true role of these sciences in the future of our country. We express our most sincere appreciation to you for this.

STATEMENT BY DR. PAUL R. SAUNDERS, PROFESSOR OF PHARMACOLOGY AND ASSOCIATE DEAN, SCHOOL OF MEDICINE, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES, CALIF.

MARCH 13, 1961.

HON. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
Senate Office Building, Washington, D.C.

DEAR SENATOR MAGNUSON: I have your letter of February 27, 1961, regarding the marine sciences bill, S. 901, hearings on which are to be held soon. I am pleased to learn that this bill proposes a substantial expansion in many areas of the marine sciences.

My own work, of which Dr. Galler spoke to you, concerns the pharmacological and chemical investigation of the potent toxins present in the venoms of a number of marine animals (fish, mollusks, and other animals). Little work has been done previously in this field, in contrast to the very large effort which has been made in studies on the vemons of terrestrial animals (snakes, insects, and others). There is a practical interest in these marine animal venoms because stings from such organisms have caused serious injury or death, and adequate treatment has not been possible because of the lack of knowledge of the nature of the poisoning produced. Certain of the venoms possess in addition unique actions which are of general scientific and medical interest.

Prior to initiation of the above studies, I worked for a number of years on various problems related to the treatment of heart disease. I was fortunate several years ago to spend 2 years at a marine laboratory, and at that time first became aware of the deficiencies in our knowledge of biologically active substances in marine organisms. We have demonstrated since that time the existence of some extremely active substances with marked effects upon mammals, and yet we have been able to study only a very few species. Other workers have demonstrated the presence of potent substances in stingrays, the Portugese man-of-war, the tissues of some fishes, various micro-organisms, and other plants and animals, but the elucidation of the nature and actions of most of these substances has not yet been accomplished.

At the present time only some of the more obvious problems are being investigated with respect to the study of substances of general biological and possibly medical interest. It is well known that many of the most useful drugs now used in clinical medicine (reserpine in high blood pressure and other conditions, digitalis in heart failure, morphine in pain, and many others) are derived from terrestrial plants, the useful medical applications of which were discovered hundreds or thousands of years ago. Such more or less "accidental" discovery of marine plants or animals of medicinal value is of course much less likely, and a more systematic exploration should be initiated. The few examples described above represent, I am sure, only a minute fraction of the biologically active substances present in marine forms. It is only through a major effort directed toward the chemical and pharmacological investigation of marine organisms that we will be able to find and evaluate existing but now unknown substances of scientific and possibly therapeutic value.

I would suggest that such studies could most effectively be carried out in a new type of research group at a marine laboratory. It it extremely difficult to pursue such studies in other than such a facility, because of the necessity of collecting and maintaining various marine animals used in the work. Furthermore, the marine laboratory provides in its existing staff persons who can be expected to provide the general biological background for such studies. It is my opinion that the pharmacological investigations should be carried out by persons with previous experience in this field, however, as the studies will involve the use of knowledge and procedures not now available in most marine laboratories. I suggest the establishment in several of the larger marine laboratories of new divisions of marine pharmacology (analogous to departments of pharmacology now in existence in schools of medicine, industrial laboratories, and elsewhere). The function of such groups would be the investigation of marine plants and animals with a view to (1) the discovery, purification, and isolation of substances with potent biological activity, and (2) the pharmacological investigation of the effects, mechanism of action, and possible therapeutic application of such substances. After compounds with potentially useful (both from the scientific and medical standpoints) actions have been found and studied in the laboratory, certain of these substances of possible therapeutic value could be investigated further at clinical research facilities such as those in many existing schools of medicine.

Previous successes in the application of naturally occurring substances derived from terrestrial organisms to the study of normal physiological processes and to the treatment of disease should encourage similar studies with marine plants and animals. It is anticipated that much knowledge of medical and scientific importance would result from expanded support of the study of the pharmacological actions of substances derived from marine organisms.

STATEMENT BY DR. MARY BELLE ALLEN, DIRECTOR, LABORATORY OF COMPARATIVE BIOLOGY, KAISER FOUNDATION RESEARCH INSTITUTE, RICHMOND, CALIF.

MARCH 16, 1961.

Senator WARREN G. MAGNUSON,
New Senate Office Building,
Washington, D.C.

DEAR SENATOR MAGNUSON: Thank you for the invitation to comment on S. 901. Needless to say, all of us who are working in the marine sciences are keenly interested in this bill and hope for its passage.

The pharmacological possibilities of material from marine plants, animals, and microorganisms are to a great extent unexplored. The work which has so far been done, however, suggests that the sea is a great storehouse of potential chemotherapeutic agents. Several common seaweeds are yielding antibiotics active against various bacteria, including the troublesome *Staphylococcus aureus*. The numerous venomous or otherwise poisonous animals found in tropical seas are also being found to contain a variety of pharmacologically active materials. There is every reason to believe that increased work in this area would be profitable to medical science.

May I also take this opportunity to comment on two other matters that may be of interest to your committee? (1) There is a great lack of basic oceanographic data for the northern California region. The Scripps Institution has worked south from San Diego, and the University of Washington north from Seattle, leaving an unstudied area in between. (2) Our competitors in the Soviet Union are employing a large number of scientists of both sexes in oceanographic fieldwork. We, on the other hand, have so far been employing mostly males. Most of our ship and field facilities are designed or operated in such a way as to discourage work by women. Since we have in this country a number of highly competent scientific women both able and willing to do work of this type, is it not wasteful of our human resources to permit this situation to continue?

Sincerely yours,

MARY BELLE ALLEN, Ph. D., *Director.*

STATEMENT OF ALBERT SZENT-GYORGYI, M.D., PH. D., LABORATORY OF THE INSTITUTE FOR MUSCLE RESEARCH AT THE MARINE BIOLOGICAL LABORATORY, WOODS HOLE, MASS.

MARCH 4, 1961.

Senator WARREN G. MAGNUSON,
Senate Office Building,
Washington, D.C.

DEAR SENATOR MAGNUSON: You invite me to expand on my earlier statement. There is one point, perhaps, which I may not have sufficiently emphasized in my earlier letter, and this is the unity of the living world and science. For many decades the trend was to subdivide nature and science into new fields. Now we begin to understand the great unity of Nature, which is built on a limited number of basic principles. The difference is very important. Earlier, we thought we would be able to solve more complex problems, such as different diseases, by a direct attack, by shortcuts. Shortcuts have turned out to be blind alleys and we have learned that the only really safe and fruitful way is to go down, first, to the foundations of Nature (this is basic research), and then come up with our newly won deeper insight to the specific areas. To quote an example of my specific personal experience, I always was interested, exclusively, in basic phenomena. All the same, unexpectedly, 30 years ago I discovered vitamin C, which, since, has saved many lives and has helped to build millions of healthy bodies. Though not being a cancer researcher, I could make, lately, a very important contribution to cancer research, and I hope that, someday, my basic studies on muscle will yield a clue to dystrophy. I would almost be inclined to say that anybody who wants to solve cancer has little chance to do so, but anyone who studies basic phenomena of life does have a chance. This is important to your problem, because the ocean, the cradle of life, offers innumerable possibilities for the approach to the most basic problems, apart from offering, also, solutions for more immediate needs. The greatest store of energy on this globe, for instance, is the so-called heavy water contained in the ocean.

I do not think that I can add, more than this, to what I have said before, nor do I think that I could improve on the language or the contents of the bill. However, if I may give you additional advice, this would be to invite Philip Armstrong as a witness to your hearings, or ask him to give his opinion, or do both. Philip Armstrong is the Director of the Marine Biological Laboratory and is also a professor at Syracuse, at the medical school. He is well acquainted with medical problems and also with the workings of marine biological laboratories. I may add to this that he is a very nice and exceedingly capable man. He is the best Director we have ever had here and he has a really broad vision on the problems involved. His address is: Dr. Philip B. Armstrong, Director of the Marine Biological Laboratory, 766 Irving Avenue, Syracuse 10, N.Y.

My own personal scientific interest is limited to the really basic phenomena of life, but Dr. Armstrong is conversant with all the interrelations of the different branches of science and would be of more help to you than I.

I sincerely regret that I will be unable to attend your hearings, being abroad in the middle of March. Needless to say, I would be delighted to support you in any way that I can.

With the best wishes and expression of my highest regard, I remain

Sincerely yours,

ALBERT SZENT-GYORGYI.

STATEMENT OF JAMES E. NOBLIN, JR., DIRECTOR OF ECONOMIC RESEARCH, MISSISSIPPI INDUSTRIAL & TECHNOLOGICAL RESEARCH COMMISSION, JACKSON, MISS.

Mr. Chairman, my name is James E. Noblin, Jr., and I am director of economic research for Mississippi's Industrial & Technological Research Commission, a research organization which marshals the research resources and personnel of our universities and colleges and of our State agencies to focus upon the research needs of scientific and industrial development in our State.

I urge that you expedite application of the major recommendations presented in S. 901, the proposed Marine Sciences and Research Act of 1961, and this is why:

First, in 1961, it is estimated that research and development spending will approach $14 billion, 12 percent more than in 1960, of which over one-half ($7.4 billion) will be expended by the Federal Government. How much of this will be spent in attempts to gain greater insight into the scientific puzzles, economic opportunities, and commercial potentialities inherent in our virgin oceans and estuaries? Unfortunately, it is a negligible amount.

Through research we expect vaccines for measles and the common cold in 1961; greatly improved fuel cells and solar cells; stronger, harder, and tougher plastics; discovery of the 103d element; launching of the first nuclear-powered merchant cargo vessel; an oral male contraceptive; dehydration of foods through freeze drying; greater understanding of the effects of radiation on life processes and of the cause of cancer; ultra-high-speed computer transistors and diodes—to name a few. And in outer space, we look for manned orbital flight in 1961; an unmanned soft landing on the moon; firing of the Centaur and Saturn supercockets; orbiting of a communication satellite and perfecting of photo and heat detector reconnaissance satellites.

But what do we expect in 1961 from research on inner space, i.e., our oceans—a few more ocean cruises; maybe a new addition to a particular phylum; some new theories but not many solutions to current problems or developments of a nature relative to other fields of endeavor.

Why this lack of progress in a field so vital to our national defense and our mutual welfare? All of the basic reasons revert back to lack of adequate financial support in the past. S. 901 attempts to attack this problem by allocating approximately $65 million annually for a coordinated 10-year program of expanded ocean, estuarine, and Great Lakes research. This vitally needed appropriation would represent only 0.8 percent of the Federal Government's total research and development expenditures for 1961.

Second, the United States is lagging behind the Union of the Soviet Socialist Republics in the important fields of oceanographic underwater research. None of our surface oceanographic ships can compare with the recent ships built for this purpose by the Russians as any witness can testify who visited the Mikhail Lomonosov during its docking in New York City for the first International Oceanographic Congress held at the United Nations in September 1959. This pride of Russia is the largest (5,960 tons) and some would say the most immaculate oceanographic research ship in the world. Are we going to wait until Russia's scientific achievements in inner space exploration pressure us into action as happened in outer space exploration?

Third, technology is becoming much more complex as a corollary to greater complexity. Practically all technologies are fast becoming more interdisciplinary, traditional boundaries between fields are collapsing, but the science of oceanography has not kept up with the other sciences in new technological advancement; thus cultivating disciplinary disputes as the boundaries between oceanography and related science fields are merged.

We have a long way to go in oceanographic research if we are to accomplish in inner space what we have accomplished in outer space. S. 901 provides the impetus for those accomplishments.

But even so, we must recognize that the cost of technological advance is rising and from all indications will continue to rise at a disturbing rate due to many factors, the major ones being the greater complexity, the highly competitive demand for technically trained personnel and the general inflationary trend. This must be carefully considered when we are discussing a 10-year program.

So, for these three reasons—to elevate oceanographic research to a position of primary importance in our Nation's total research effort, to assure the United States of world leadership in the exploration of inner space and to make oceanographic technology more dynamic—I urge you to authorize the marine sciences and research program as stated in S. 901.

The ocean has been good to Mississippi. It gives employment to 10,000 Mississippians and is responsible for approximately 12 percent of our total personal income. We extract magnesium from it; we build surface and underwater vessels to traverse its great expanses; we process its shrimp, oysters, crab, tuna, and menhaden for nationwide consumption, and we are beginning to exploit its centuries-old world trade lanes. It is the benefactor of our second largest industry—tourism.

We are located along an 88-miles central section of the northern perimeter of the Gulf of Mexico—66,000 square miles of water entirely different from the Atlantic or Pacific Oceans. Today we know very little about the Gulf of Mexico; it has never been studied in any great detail. Here a great river discharges into a relatively quiet body of water. Sedimentation occurs at a rapid rate offering unhampered possibilities for advanced study of earth history. Absence of ocean floor currents suggest investigation into the disposal of low-level radioactive waste in the sludgey Mississippi River estuaries. Better control is afforded over oceanographic sampling and observation techniques in this calm portion of the Atlantic Ocean. Only 50 miles apart in Mississippi are two river systems, both of which flow into the gulf; one is highly contamined by municipal and industrial wastes; the other, the direct antithesis. Ecological and hydrographical studies of these river systems can establish a basis for intelligent appraisal of estuarine problems and properties throughout the Gulf of Mexico area. Research in marine chemurgy appears promising and profitable to the gulf coastal areas. Mississippi realizes the great unexploited potential of our ocean and is vitally interested in the furtherance of oceanographic research—especially utilization research.

In this context I would like to offer a few suggestions.

First, as to the objective, certainly the research under this program must be of a useful type. The last thing the country needs is another 500 research pamphlets to go on shelves. This is not to say that basic research is unimportant. It is important, but we have problems and the kind of research we presently need is the kind which is specifically oriented to these problems.

What kind of a framework is needed to assure us that we can accomplish this kind of research? Responsibilities of the some 17 governmental agencies involved in S. 901 should be clearly defined, homogeneous and flexible. Disputes over which agencies should finance a specific research proposal should not occur if responsibility and authority are properly delegated and understood. If there is not to be a centralized agency to oversee this program—and it is our belief that there should be—then, there should at least be a versatile coordinating committee or commission. This program must be properly formulated, coordinated, administered, and controlled if it is to accomplish the greatest good. Accountability of these agencies to such a commission for the successful implementation of this program is vital to the program's overall success. Essential to effective coordination is adequate communication, and assurance of properly operating channels of communications at all times among this many governmental agencies is in iteself a herculean task.

This framework is further supported by the knowledge that to secure satisfactory results, a program must be planned. It is imperative that such a long-range program as this have a plan. Any research is dynamic. Denial of top-echelon planning ignores the fact that the operative level will ever face a choice among alternatives. When you deny the need for planning, implementation of your program is based on chance or emergencies. A good plan promotes the confidence that helps lead to success.

Through such a framework, we should administer all Government-financed oceanographic research. There should be no cleaverage of military and civil oceanographic research. Avoid the delecate situation that accompanies our outer space research program; profit from that experience.

Administration of this program should be a team effort, and such a team should be versatile to give the group breadth and stability. This administrative body should include representatives of the engineering (especially electronic), economic, legal, and sociological professions in addition to earth scientists.

Such a group should then be memorialized to conduct a complete rethinking about inner space research, a reorientation of the state of the oceanographic art. A few examples: How many already perfected items, especially electronic and bionic, used in outer space exploration could also be effectively used in exploration of inner space? Why not an orderly plan for deep ocean research—we did not attempt to orbit a human being in our initial outer space probe. Why can't more mothballed ships be overhauled for research use in contrast to construction of new ships? Should not more emphasis be placed on use of converted submarines for oceanographic research?

I present these comments for your consideration.

It is significant to note that wherever money has been spent in the past to outfit and encourage marine laboratories, oceanic research vessels, and marine studies, big dividends have eventually resulted. This has been true in Britain, Norway, Japan, France, Portugal, Iceland, and the Soviet Union. Research in the marine sciences takes place in several institutions in the United States. The two most prominent organizations are Scripps Institution of Oceanography in California and Woods Hole Oceanographic Institution in Massachusetts. The former is supported by the Navy and the University of California; the latter primarily by Navy funds. Several oceanographic stations, all with university ties, are active: For example, the University of Washington, Texas A. & M., the University of Miami, Johns Hopkins University, Chesapeake Bay Institute, and Columbia University at the Lamar Geological Observatory. The Nation also has 10 to 20 small marine laboratories.

Expansion of present research establishments and creation of new ones must be accomplished. It is becoming more apparent that our knowledge of the ocean is closely linked to national security, and thus is of critical importance, but we lack sufficient basic understanding of the ocean. The attainment of increasing degrees of understanding will not only keep the level of oceanographic knowledge on a par with that in the other sciences, but will also contribute solidly to our military well-being and to our future integrity as a Nation.

Meanwhile, as always, research remains a gamble but increasingly less so than the lack of research.

Thank you.

COMMUNICATION FROM DR. FRANCIS H. HORN, PRESIDENT, UNIVERSITY OF RHODE ISLAND, KINGSTON, R.I.

FEBRUARY 27, 1961.

Senator WARREN G. MAGNUSON,
Chairman, Interstate and Foreign Commerce Committee,
New Senate Office Building, Washington, D.C.

DEAR SENATOR MAGNUSON: I strongly endorse Senate bill S. 901 incorporating the recommendations of the Committee on Oceanography of the National Academy of Sciences and Project TENOC of the Office of Naval Research. The importance of this bill in providing for facilities, research, and the training of scientific personnel for national defense and for proper exploitation of the resources of the sea cannot be too strongly emphasized.

The Narragansett Marine Laboratory of the University of Rhode Island, after 13 years of contracts with the Office of Naval Research, has been selected for participation in the Navy 10-year oceanographic program and has received additional basic marine research grants from the National Science Foundation, the National Institutes of Health, and the Atomic Energy Commission. The oceanographic research and educational potentials of this laboratory are being further enhanced by elevation to graduate school status.

We highly commend you for your vigorous efforts and assure you of our interest in the passage of the Marine Sciences and Research Act of 1961.

Cordially yours,

FRANCIS H. HORN, *President.*

COMMUNICATION FROM DR. WILLIAM R. WOOD, PRESIDENT, UNIVERSITY OF ALASKA, COLLEGE, ALASKA

MARCH 20, 1961.

Senator WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: I appreciate very much your sending me materials concerning the proposed marine sciences program. As you know, the University of Alaska is very deeply interested in your proposal. You may recall that the State legislature a year ago authorized the establishment of an institute of marine sciences, and that Dr. Kenneth M. Rae has been selected as a director of this institute. He is presently head of oceanography and marine sciences at Texas A. & M.

It seems to me that the University of Alaska, with its main campus located at 65° north latitude, and representing as it does, a State with many thousands of miles of shoreline in the Arctic and North Pacific regions, is ideally located to serve as a center, not only for research in oceanography and marine sciences, but also for the training of oceanographers and marine scientists for work in the Arctic and in the Antarctic.

I am sure that the members of the Alaska congressional delegation, Senator Bartlett, Senator Gruening, and Representative Rivers, will agree with me on this point.

Sincerely yours,

WILLIAM R. WOOD, *President.*

TELEGRAM FROM G. A. SLIFER, GIBBS CORP., JACKSONVILLE, FLA.

JACKSONVILLE, FLA., *March 15, 1961.*

Hon. WARREN MAGNUSON,
Committee on Interstate and Foreign Commerce, Senate Office Building, Washington, D.C.:

As one of the leading builders of ships used for oceanography and fishing research, we respectfully urge your committee's support of bill S. 901 dated February 9, 1961. Not only are the existing oceanographic research vessels obsolete and should be replaced, but a better knowledge of the minerals available in the sea will contribute more to the national welfare than the vast exploration of space which is now consuming such a large share of the taxpayers' money.

G. A. SLIFER.

TELEGRAM FROM AUBIN R. BARTHOLD, PRESIDENT, ASSOCIATION OF PACIFIC FISHERIES

SEATTLE, WASH., *March 17, 1961.*

Senator WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce, Senate Office Building, Washington, D.C.:

Association of Pacific Fisheries strongly endorses S. 901 and urges close coordination of studies in physical oceanography with studies directed at solution of our urgent fisheries problems.

AUBIN R. BARTHOLD, *President.*

TELEGRAM FROM JOHN N. PLANCICH, PRESIDENT, PUGET SOUND SALMON CANNERS, INC.

SEATTLE, WASH., *March 17, 1961.*

Senator WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce, Senate Office Building, Washington, D.C.:

Imperative that United States proceed with oceanography research and coordinate it with fisheries research which is also of vital importance.

JOHN N. PLANCICH, *President.*

COMMUNICATION FROM DR. J. E. LIPP, CORPORATE DIRECTOR OF DEVELOPMENT PLANNING, LOCKHEED AIRCRAFT CORP., BURBANK, CALIF.

MARCH 4, 1961.

Hon. WARREN G. MAGNUSON,
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: Thank you for your letter of February 28, 1961, concerning the coming hearings on S. 901, the new bill on marine sciences. I shall not be able to attend the hearings of March 15–17 in Washington, however, I shall place my comments in this letter.

Although the sea is man's oldest ancestral environment it is also his newest, and receptive to a massive technical and industrial penetration in the next few decades. There is now little doubt of our basic ability to improve economic or living standards the world over by energetic exploration and development of the oceans. The United States must lead this trend, for its own progress as well as to assure stability and peace for future generations. A world with adequate water, food, and material supplies will be a world of reduced tensions, reduced warfare, increased welfare.

A program of marine development, to be effective on a large scale, must be comprehensive and well organized. Clearly, encouragement by the U.S. Government will be decisive in placing this country on a path of rapid advance in knowledge, with rapid and beneficial application of that knowledge.

The proposed bill, S. 901, is a major step in declaring national goals in marine science, as well as erecting the program and finances necessary to achieve those objectives. In our opinion, every effort should be made in this session of Congress to pass the bill and to follow it with any steps necessary to place the program in effect. Further, we believe that public opinion will approve such a move as being in the interest of the national welfare and security.

Sincerely yours,

J. E. LIPP,
Corporate Director of Development Planning.

COMMUNICATION FROM MR. K. ROBERT HAHN, EXECUTIVE VICE PRESIDENT, LEAR, INC., SANTA MONICA, CALIF.

MARCH 17, 1961.

Subject: S. 901.

Hon. Senator WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: We have read with a great deal of interest your proposed bill for Marine Sciences and Research Act of 1961, and sincerely believe that a national oceanographic program and policy should be enacted. There is a need for strong leadership, direction, and coordinated long-range planning in this total effort and assurance that multiprogram efforts are not duplicated and wasteful within the several Government agencies and private institutions. With this kind of leadership, there will be a tremendous payoff to our national welfare and defense.

This program is long overdue and you can count on our support in assisting in anyway we can to support enactment of this legislation in 1961.

Very truly yours,

K. ROBERT HAHN, *Executive Vice President.*

COMMUNICATION FROM DR. F. E. ELLIOTT, ADVANCED UNDERSEA WARFARE ENGINEERING, DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC CO.,
Ithaca, N.Y., March 16, 1961.

Hon. WARREN G. MAGNUSON,
U.S. Senate, Washington, D.C.

MY DEAR SENATOR MAGNUSON: Thank you very much for the copy of S. 901, and let me congratulate you on the excellent work you and your committee have done.

Since you are inviting comments and suggestions, I would like to make a recommendation. I believe that the bill would be greatly enhanced if the Congress would authorize the establishment of a central interagency clearinghouse for oceanographic instrumentation.

One of the great problems connected with oceanographic instrumentation is that most equipment is built at institutional laboratories, works only for the individual who has built it, and does not lend itself to production. However, there is a great deal of development and production know-how in private industry, and also a willingness to contribute to this great oceanic development program. At the present time there is no central place in the Government where industry can go to get information on what is needed; nor where to offer an instrument that has been designed; nor where to submit a proposal. It is very time consuming and therefore costly to make the rounds from agency to agency, bureau to bureau, department to department, ad infinitum, only to learn later that one has missed the unit that has an urgent need for a certain piece of equipment.

Much time and money could be saved and duplication avoided by having this clearinghouse, which should be abreast of the needs of the 16 Federal agencies mentioned on page 6 of S. 901, and should be aware of who is doing what. In other words, those in private industry who are willing to contribute their engineering resources and know-how cannot only be informed of the needs, but also be directed to the appropriate person in case he wishes to offer specific instruments, systems, etc.

My recommendation is based on over 10 years' experience as an oceanographer with the Woods Hole Oceanographic Institution, the Navy Hydrographic Office, and the General Electric Co.

Sincerely,

FRANCIS E. ELLIOTT.

COMMUNICATION FROM MR. W. T. SHANNON, DIRECTOR, DEPARTMENT OF FISH AND GAME, STATE OF CALIFORNIA

SACRAMENTO, CALIF.

HON. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: Thank you for your letter of March 9, 1961, requesting comments on your bill to authorize a national 10-year program of oceanographic and Great Lakes research and surveys.

We have read the copy of the bill S. 901, dated February 9, 1961, and would again like to take the opportunity to congratulate you for the great forethought that will certainly enable the development of our Nation in the marine area when your bill becomes law.

The modified bill embodies those suggestions that we sent to you in our letter of March 1, 1960, and because they do we can heartily support the present version. We think it is a fine piece of work and will result in a widespread increase of the knowledge of the marine environment, which this Nation will so vitally depend upon in the future in both the resources as well as the environmental area. You have our wholehearted support.

Sincerely,

W. T. SHANNON, *Director.*

COMMUNICATION FROM DR. JOSEPH L. MCCARTHY, DEAN, THE GRADUATE SCHOOL, UNIVERSITY OF WASHINGTON, SEATTLE, WASH.

MARCH 16, 1961.

HON. WARREN G. MAGNUSON,
Senate Office Building, Washington, D.C.

DEAR SENATOR MAGNUSON: This letter is written to set forth an opinion in support of the need for legislation of the type proposed in Senate bill 901 (Marine Sciences and Research Act of 1961) and to suggest the influence that such legislation may be expected to exert on programs being conducted at the University of Washington. During the last session of Congress, a number of members of our faculty made comments and suggestions relating to Senate bill 2692 and this information is, of course, already available.

The University of Washington, by reason of its location in Seattle, Wash., and by reaosn of the importance of the ocean in many aspects of the life of the citizens of the State of Washington, has a long tradition of teaching, research, and service in oceanography and the marine sciences. For nearly 60 years out of the even hundred years of the existence of the university, members of the faculty in the fields of oceanography, fisheries, biology, and other related fields of science and technology have focused their attention on the seas.

At present the university is reviewing its total effort in the field of marine sciences. This review is being carried out by a committee of the faculty and the findings will provide a broad picture of the present status of the marine sciences at the university. This same committee has also made substantial progress in formulation of a plan for the further development of marine sciences at the University of Washington.

You and your colleagues have invited representatives of the university to present statements on Senate bill 901 before the Senate Committee on Interstate and Foreign Commerce and we are honored and pleased that this opportunity is being provided. Information concerning graduate and undergraduate programs of teaching and research is being given by Dr. Richard H. Fleming, professor and executive officer of the department of oceanography. Some of the university's programs of research in the marine sciences will be described by other members of the faculty, i.e. Dr. Robert L. Fernald, associate professor of zoology and director of the Friday Harbor Laboratories, Dr. Lauren R. Donaldson, professor of fisheries and director of the Laboratory of Radiation Biology, and Dr. Joseph E. Henderson, professor of physics and director of the Applied Physics Laboratory. Additional information will be provided to your committe by Dr. Dixy Lee Ray, associate professor of zoology and member of the National Academy of Science Committee on Oceanography.

Of foremost interest at the university is the academic program of teaching in oceanography and the marine sciences. Direct teaching activities in the marine sciences are being conducted in the department of oceanography, the college of fisheries, the departments of botany, zoology, and microbiology and in other units of the university. The University of Washington has trained a substantial proportion of the specialists who now occupy positions of responsibility in the governmental and industrial agencies concerned with basic and applied research in the fields of marine sciences and with management of resources relating to the ocean. As is indicated by the testimony of Professor Fleming and others, the university sees a real need to expand substantially the number of qualified persons who complete university training in the fields of oceanography and marine sciences.

Also of major importance is the responsibility of the university to carry forward basic research through the activities of members of the faculty and their graduate students. Vigorous research programs are now proceeding in all of the units of the university concerned with the marine sciences. By such research, students are challenged and trained in the critical and disciplined atmosphere of a university. New knowledge is obtained from such faculty and graduate student research which is of general interest to people of the State and of the Nation.

An additional responsibility is that of public service provided in the contributions of the several special research laboratories associated with the university, and especially those laboratories engaged in research relating to national defense. As emphasized in the November 15, 1960, statement of the President's Science Advisory Committee under the title "Scientific Progress, the Universities and the Federal Government," it is of particular importance that research programs in the basic sciences be carried out in association with universities. The University of Washington has already had wide experience in maintaining and sponsoring such laboratories and believes that further development of this type of facility is needed in the fields of oceanography and marine sciences.

To move forward in teaching, research, and service, the university finds that substantial problems lie before it. The passage of Senate bill 901 would apparently provide for assistance to the University of Washington and other universities in carrying forward programs in the academic tradition, as well as those of urgency in the public interest and national defense. Some specific types of assistance which are needed and which would apparently be provided by the authority and arrangements in Senate bill 901 will now be mentioned.

The need is great for additional scientists and technologists highly trained in the marine sciences. Therefore, it seems particularly important to provide arrangements for fellowships and assistantships to graduate students engaged in programs of study and research leading toward advanced degrees.

To carry forward an expanded program of teaching and research in oceanography and the marine sciences, expansion is needed in the number of faculty in these fields, and in financial support for these men. The universities are hard put now to provide for the needed increases in faculty personnel.

The need is equally great for physical facilities for teaching and research. At the University of Washington, laboratory space suitable for work in many of the marine sciences is now almost completely filled. Additional facilities, including buildings, laboratories, libraries, conference rooms, and offices, are needed.

Teaching and research activities relating to the ocean also require ships of specialized design, docks, wharves, and service facilities. Shore-based laboratories must be available to assist in the servicing of teaching and research ships, as well a to maintain vigorous and independent research programs.

The modest funds available to the university cannot provide these costly activities and facilities. The basic source of financial support of the University of Washington is, of course, provided by the State of Washington. Over the years, the State has financed the development of oceanography and marine sciences to the present very substantial level which now prevails. It is anticipated that this State support for the teaching and research programs will be maintained and, insofar as circumstances permit, expanded.

However, the substance of Senate bill 901 stresses the national significance of oceanography and the marine sciences so that it seems appropriate for the university to look to the National Government as well as the State government to provide funds for support of oceanography and marine sciences.

Therefore, because of both need and appropriateness, I am glad to write this letter outlining the role and needs of oceanography and marine sciences at the University of Washington and to indicate to you and your colleagues our favorable view of Senate bill 901.

Yours very sincerely,

JOSEPH L. MCCARTHY,
Dean, Graduate School.

COMMUNICATION FROM DR. ALAN BERMAN, ASSOCIATE DIRECTOR, HUDSON LABORATORIES, COLUMBIA UNIVERSITY, DOBBS FERRY, N.Y.

MARCH 9, 1961.

Hon. WARREN G. MAGNUSON,
Chairman, U.S. Senate Committee on Interstate and Foreign Commerce,
Washington, D.C.

DEAR SIR: I have recently finished reading a copy of your bill S. 901. I would like to congratulate you on the general excellence of your bill. I believe that you have covered all the reasonable needs of the oceanographic community.

I am somewhat concerned about the provisions limiting the size of proposed oceanographic research vessels. The proper size of an oceanographic research vessel is a matter of personal preference which has been based on the experience of individual laboratories. At our laboratory we operated for many years with a vessel of roughly 900 tons displacement, and were convinced that this was somewhat inadequate. We were quite fortunate to be assigned the services of the USNS *Josiah Willard Gibbs*. To my knowledge, this vessel with a displacement of slightly over 3,000 tons is the largest and most modern vessel operated by the United States for research purposes. We have been overwhelmingly impressed by the increase in our research capability which came about with the addition of such a large vessel. At this point we have considerable difficulty in convincing any of the scientists in this laboratory to plan experimental work on any of the smaller vessels which are at our disposal. The point is that as better and larger ships become available, the scope of work increases commensurably. I would therefore submit that you might reexamine the question of the maximum tonnage of oceanographic research vessels which would be permitted under this bill.

It is recognized that the choice of vessel design depends on many complex factors. However, I think for a long range program of capital investment in oceanographic instrumentation, it would be best to have some ships of quite a bit larger tonnage than those specified in your bill.

Very truly yours,

ALAN BERMAN,
Associate Director, Hudson Laboratories.

COMMUNICATION FROM DR. FRANCESCO B. TRAMA, RUTGERS—THE STATE UNIVERSITY, NEW BRUNSWICK, N.J.

MARCH 19, 1961.

Re S. 901.

Hon. WARREN MAGNUSON,
U.S. Senator,
Washington, D.C.

DEAR SIR: It has recently come to my attention that you have reintroduced a bill into the Senate of the United States entitled, "Marine Sciences and Research Act of 1961." May I commend you and your committee on this action.

A Federal act as you have indicated is long overdue. There are numerous potential centers for research and capable personnel in our universities as of now. What is lacking is a unified plan and the available funds for both basic and applied research.

I was especially pleased to note that your bill included the Great Lakes because these fresh waters constitute one of our greatest natural resources. To date there has been relatively little basic research performed on these huge bodies of water. This I know because I have been a research associate on the summer staff of the Great Lakes Research Institute, University of Michigan, for the past 4 years. At the present time I am desperately seeking financial support for a very basic study on the primary productivity of the Great Lakes. The National Science Foundation was unable to support this research not because it was unsound, but because their funds are limited and apparently distributed with respect to field of study and the geographic location of the study and institution.

Your proposal to create a Division of Marine Sciences within NSF and to include six scientists on the committee is, in my opinion, most intelligent and shows considerable foresight on your part.

Sincerely yours,

FRANCESCO B. TRAMA,
Assistant Professor.

COMMUNICATION FROM DR. ROSS F. NIGRELLI, DIRECTOR, LABORATORY OF MARINE BIOCHEMISTRY & ECOLOGY, THE NEW YORK AQUARIUM, BROOKLYN, N.Y.

MARCH 8, 1961.

Hon. WARREN G. MAGNUSON,
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: Thank you very much for your kind letter of February 27. I read with considerable interest your speech on the national marine science program and the bill S. 901 that will implement this program. Both are excellent, and it is my fond hope that no delay will be encountered in starting the lines of research suggested in them. These should have far-reaching effects to the economy and health of our Nation and to help secure the national defense.

I am sorry to inform you that I will not be able to attend the hearings scheduled for March 15, 16, 17. I am committed to meet with various Federal, State, and university scientists on a "swing trip" through some of our Western States to discuss a problem of great importance to the trout hatcheries in this country. Some years ago I indicated to fishery biologists that the possibility existed that our beautiful, native rainbow trout may be susceptible to liver cancer under the artificial conditions that are presently employed in our hatcheries. In the early part of 1960, liver tumors were noticed in rainbow trout in California and Washington, and this condition has since been found to be widespread in all hatcheries in this country. I am reporting this item to point out one of the problems that illustrates the importance of including the Public Health Service in your proposed program of marine science. Cancer is found among all fishes, and the growths are no different from those that occur in man and in animals generally.

I would like to take this opportunity to reiterate what I previously suggested and which you recorded in your speech of February 9, namely that: Marine organisms may be the source of important pharmacological agents. In addition to the general statements and the few specific items cited in your report, I would like to refer you to pages 257–259 of my presidential address to the New York Academy of Sciences in December 1957, entitled "Dutchman's Baccy Juice, or Growth-Promoting and Growth-Inhibiting Substances of Marine Origin."

May I call to your attention a few of the more interesting biochemicals that have been isolated from the tissues and body fluids of fish and many invertebrates? For example, (1) ergosterol and dihydro-ergosterol from the marine annelid *Arenicola*, (2) morrhuic acid from the liver of codfish, the sodium and copper salts of which are effective as a reticulo-endothelial stimulant and as a sclerosing agent, (3) tetra-ethyl-ammonium chloride and related quaternary ammonium compounds from sea anemones and numerous other marine invertebrates, which are known to have the autonomic actions both of the muscarinic and nicotinic types, (4) trignonelline (nictoinic-methyl-betaine), a common plant alkaloid, which also occurs in sea urchins and jellyfish, (5) amine oxidase from the mollusc, *Sepia*, an enzyme that is active in the oxidative deamination of tyramine, (6) sulfatases from numerous snails, especially periwinkles, and (7) thiaminase from herrings, smelts, clams and other bivalves.

I would also like to call special attention to two more important compounds. Murexine or urocanyl-choline has been isolated from glands of the snail, *Murex*, by Prof. V. Erspamer of Italy. This substance has very strong nicotinic and curariform actions, and Serotonin (5-hydroxytryptamine) is now known to be abundant in clams, octopus, jellyfish and many other marine invertebrates. This chemical has been found in the blood, brain and certain tumors of man, and Dr. Irvine H. Page (*Scientific American*, vol. 197, No. 6, pp. 52–56, 1957) has stated that "Serotonin may well become a capital clue to the biochemistry of sanity and insanity."

In addition, basic types of compounds that have been identified as derivatives from marine animals and algae include many new sterols, lipids, carotenoids, porphyrins, pterins, peptides, new types of nucleosides, all the known and many as yet unindentified kinds of amino acids, glycoproteins, polysaccharides, alkaloids, vitamins, hormones, enzymes, antibiotics and others. Of special interest are the numerous toxic compounds that are known to occur in marine organisms. Their potential use as drugs has been suggested by several investigators.

I am enclosing two timely articles on "Research in the Seas" that were written by Dr. Howard A. Rusk and published in the New York Times on February 26 and March 5, 1961. The reference to the work of Dr. C. P. Li (U.S. Public Health Service) on abalone juice with antipoliomyelitis properties should be of considerable interest to virologists.

Finally, I would like to point out one area in which a pharmaceutical product derived from a fish is playing a well established role in national defense. Studies on the physiology of the electric eel, first initiated in the laboratory of the New York Aquarium, led to the discovery that this fish contains large amounts of cholinesterase (or acetylcholinesterase), which is an enzyme vital to the transmission of nerve impulses. This enzyme is now being extracted and purified in quantity. With this and the electric eel as an experimental animal, it was possible for Dr. I. B. Wilson to synthesize an antidote for nerve gases called PAM. Although the electric eel is at present the primary and most available source of the enzyme, there are several marine fishes that could be also used as a source. The electric torpedoes, which contain large amounts of this enzyme, are widely distributed along our Atlantic and Pacific coasts and are available in large numbers. The work on the electric eel is being carried on by Dr. David Nachmansohn and his associates at the College of Physicians and Surgeons, Columbia University, New York City.

I hope that these few remarks have been of interest to you and will prove so to the other members of your committee.

Sincerely yours,

Ross F. Nigrelli, *Director.*

COMMUNICATION FROM MR. WAYNE D. HEYDECKER, SECRETARY-TREASURER, ATLANTIC STATES MARINE FISHERIES COMMISSION, MOUNT VERNON, N.Y.

March 16, 1961.

Senator Warren G. Magnuson,
Chairman, Senate Committee on Interstate and Foreign Commerce,
The Capital, Washington, D.C.

My Dear Senator Magnuson: Thank you for your courtesy in sending us two copies of your bill, S. 901.

Our commission by resolution No. 11 adopted at its 19th annual meeting urged your committee to reintroduce last year's bill S. 2692 to advance the marine sciences by establishing a 10-year program of oceanographic research, surveys, and so forth. The resolution was as follows:

11. Bill to Advance Marine Sciences and Oceanographic Research:

"Whereas the Committee on Interstate and Foreign Commerce—Hon. Warren G. Magnuson, chairman—reported favorably upon a bill (S. 2692) 'to advance the marine sciences, establish a 10-year program of oceanographic research and surveys, promote commerce and navigation, secure the national defense, expand ocean resources, authorize the construction of research and survey ships and facilities, assure systematic studies of effects of radioactive materials in marine environments, enhance the general welfare and for other purposes' (Calendar No. 1588, Rept. No. 1525, June 7, 1960, 86th Cong., 2d Sess.); and

"Whereas among its several values, the marine sciences research program outlined in S. 2692 would materially benefit the fisheries of the United States; be it hereby

"Resolved, That the Atlantic States Marine Fisheries Commission, through the communication of copies of this resolution to the Committee on Interstate and Foreign Commerce, urge the committee to reintroduce the marine sciences act and urge the Senate and the Congress to pass the bill."

As we said last year the important thing is to agree on the objectives and concentrate on getting the program started. Our commission has taken no position on the details of your bill or on the bill by Representative Miller H.R. 4276 introduced in the House February 13, 1961 which seeks the same objectives by a somewhat different approach.

Nevertheless in conversation on the matter several points have arisen, which I believe it may be proper for me to mention to you unofficially.

There are some misgivings about the wisdom of the specific limitations in your bill, as to the amounts of money which may be expended in any one year for specific purposes. This may be desirable from the standpoint of the budget authorities and helpful in securing passage of the bill, but it might prove to be an unwise limitation as the program unfolds because it may be found from time to time that emphasis in greater measure should be placed on some phase of the program with correspondingly greater costs. In such an event the limitations set forth might seriously handicap the program. Thus it would seem to be desirable to have a greater degree of flexibility, possibly by the omission of the specific limitations of expenditures in a single year.

The provisions of Representative Miller's bill H.R. 4276, provide such flexibility through annual review of projects and requests for appropriations for a program approved by a council of six containing four Cabinet members, but it may be unrealistic to expect the four busy Cabinet members to devote the time necessary to administer personally such a program. It seems more likely that in practice they might find it necessary to delegate such responsibility to an Assistant Secretary, either one already burdened with administrative responsibilities or perhaps one chosen especially for the purpose. This naturally raises the question, would it be more realistic to designate such Assistant Secretaries as members of the council in the first place? There may be a precedent for such action in the present Interagency Committee on Oceanography headed by an Assistant Secretary of the Navy and often referred to as the Wakelin committee.

I have ventured to speak of these matters because in your recent letter you requested comments, but I must emphasize again, that these are points that have arisen in conversations on these matters and should not be regarded as official recommendations.

The only official position of the commission is contained in resolution No. 11 adopted at our 19th annual meeting in Charleston, S.C. which appears at the beginning of this letter.

Respectfully yours,

WAYNE D. HEYDECKER, *Secretary-Treasurer.*

COMMUNICATION FROM DR. CHARLES C. WILBER, CHIEF, EXPERIMENTAL ZOOLOGY BRANCH, AND DIRECTOR OF MEDICAL RESEARCH, U.S. ARMY CHEMICAL RESEARCH AND DEVELOPMENT LABORATORIES, ARMY CHEMICAL CENTER, MD.

MARCH 14, 1961.

HON. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
Senate Office Building, Washington, D.C.

DEAR SENATOR MAGNUSON: Thank you very much for sending me your recent communication concerning the national marine science program which you are sponsoring in the Senate. I appreciate having the copy of your speech of Thursday, February 9, 1961, on the subject of the national marine science program. I was especially glad to have a copy of S. 901, the "Marine Sciences and Research Act of 1961" a bill which you are introducing into the Senate for action.

I read the bill with interest and in detail. The overall impression I got was most favorable. I sincerely hope that you will be able to facilitate the passage of this bill.

May I make a few comments which are intended to be constructive and in no way adversely critical of the bill as it stands? On page 4, line 17, would it be useful to include the word "physiology," before the word "behavior." If we are to have a thorough knowledge of marine and aquatic life we must have a comprehensive appreciation of the physiology of the individual organisms which are making up marine and aquatic life.

Later in the bill I notice that you do cover the matter of physiology adequately. I would hate to have it neglected by oversight.

I think that the idea of a National Oceanographic Data Center is superb. Many of our difficulties in the various aspects of science today stem from the fact that we do not have a central clearing house for data. Even data which are collected by Government agencies are lost almost as fast as collected. This oceanographic data center will be a step in the right direction.

On page 10, line 18, I notice that there is a limitation of $480,000 per year with respect to the maximum expenditures which will be allowable for education and training in the marine sciences. For the first few years this may be adequate. I pose the question whether such a restriction may cause operating difficulties during later stages of the program. I presume that amendments can be made in later years. However, I am merely posing this possible difficulty.

I am especially pleased to note that adequate provision has been made to insure that biological oceanography will be properly supported by the proposed expenditures. Several draft copies of bills which I read last year had this glaring fault; there was no specific mention of the biological aspects of the program. I feel that this has been corrected in the draft of the bill which you sent to me; this is a wise move.

I refer to page 55 of the draft of the bill. If this type of construction were now put into effect it might do much to shore up our economy. It certainly would provide jobs in various areas of the country for construction workers and supporting services.

There is very little I can add to what I consider a satisfactory draft of a bill. If there is any way in which I can aid in insuring the passage of this bill I will be only too happy to do so. Should you wish me to testify before your committee with respect to this bill or to help in any other way please feel free to call on me.

For your information I will be leaving these laboratories on May 1, 1961, to take up a new position as dean of the Graduate School and professor of biology in Kent State University, Kent, Ohio. Therefore you can understand that I will have an even greater interest in the education, research, and training aspects of this bill.

Again I thank you for letting me see this draft of the bill and for asking for my comments. My main comment is, "Do whatever you can to get this bill passed as soon as is feasible."

With highest personal regards to you, I am,

Cordially yours,

CHARLES G. WILBER, Ph. D.

COMMUNICATION FROM MR. G. B. TALBOT, BEAUFORT, N.C.

MARCH 21, 1961.

Hon. WARREN G. MAGNUSON,
U.S. Senate, Washington, D.C.

DEAR SIR: As a former resident of the State of Washington and as a marine biologist, I wish to commend you for your tireless effort during the past years preceding your introduction of S. 901 bill to the 87th Congress. I believe passage of this or a similar bill is mandatory if the United States is to maintain itself as a leading country in scientific progress. In fact, the continued existence of this Nation as a free and democratic country may well depend upon research as you have outlined in your marine science bill.

I will be watching developments of this bill in the Senate and Representative Miller's bill in the House of Representatives with a great deal of interest. I wish you success in getting S. 901 passed in the Senate, and hope that it will pass in the House with little or no change. You can count on my continued support.

Very truly yours,

G. B. TALBOT.

COMMUNICATION FROM DR. R. A. RAGOTZKIE, DEPARTMENT OF METEOROLOGY, UNIVERSITY OF WISCONSIN, MADISON, WIS.

MARCH 15, 1961.

Hon. WARREN G. MAGNUSON,
Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: I should like to compliment you on your speech of February 9, 1961, introducing Senate bill 901 on marine sciences and research.

My comments on this bill are as follows:

1. The training aspects cannot be overestimated. We at the University of Wisconsin are presently organizing a graduate program in oceanography for Ph. D. candidates. Any assistance we can obtain in this will tend to accelerate the program since students are already available.

2. Section 4(e) mentions marine geophysical remote sensing and recording systems. This is a major research interest in the Department of Meteorology and we are hampered at present only by lack of stable support. Aircraft operations are expensive and cannot be financed efficiently on short-term research

contracts. Furthermore we are in a position to train graduate students in the skills necessary for this type research. Let me point out that one aircraft properly equipped can accomplish in 1 day on one of the Great Lakes what would require perhaps a week's work by several research ships. The savings in money and manpower are obvious.

We are watching the progress of bill 901 with great interest and hope it will be approved by the Congress as soon as possible.

Thank you for keeping me informed.

Sincerely yours,

R. A. RAGOTZKIE,
Assistant Professor.

COMMUNICATION FROM DR. WILLIAM H. MCGRATH, ASSISTANT DEAN OF STUDENTS, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES, CALIF.

MARCH 16, 1961.

Senator WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
New Senate Building, Washington, D.C.

DEAR SENATOR MAGNUSON: The following statement is respectfully submitted to the Committee on Interstate and Foreign Commerce. There exists in the United States today numerous yachtsmen who are both affluent and influential as well as intelligent and interested in oceanography.

These businessmen and executives could easily be encouraged toward oceanographic research by a favorable rider on an oceanographic bill. This rider could permit a very modest tax benefit for those skippers who would, for example, install aboard their yachts at least $1,500 worth of oceanorgaphic research gear and who would actually engage in the solution of a significant oceanographic problem.

The validity of each skipper's research program could be cleared through facilities of existing research institutes. (We all have far more research ideas than we can ever work on.)

The above is based on several important contributions by laymen, an example of which is: The most significant oceanographic discovery of the past 100 years (the subsurface eastbound equatorial current of the Pacific) was made by the boy, Townsend Cromwell, who flunked out of Scripps Institute of Oceanography. He noted that "far too much water flowed west and nowhere enough flowed east according to all the textbooks. Therefore, there must be a giant eastbound current somewhere." A few dollars worth of floats and bottles were dropped through the well-known well-traveled westbound Pacific Equatorial Current. The astounding results showed this current to be very shallow and that the massive movement of water was in the opposite direction—west to east.

Sincerely yours,

WILLIAM H. MCGRATH.

(The following information was subsequently submitted for the record:)

U.S. SENATE,
COMMITTEE ON AGRICULTURE AND FORESTRY,
March 22, 1961.

Hon. WARREN G. MAGNUSON,
Chairman, Senate Committee on Interstate and Foreign Commerce,
Senate Office Building, Washington, D.C.

DEAR MR. CHAIRMAN: You are to be congratulated on the foresight and perseverance with which you have promoted legislation to further research in the marine sciences. This vast field holds enormous potential for mankind, yet it has been largely ignored until your hearings last year and again this year opened up to the general public the need to explore the secrets of "inner space," the oceans.

The primary purpose of S. 901, as of last year's bill, is to enhance the national economy, security, and welfare by increasing our knowledge of the oceans and the Great Lakes in physics, biology, chemistry, and geology of the sea. The bill would approximately double the capabilities of the United States in this area within the next 10 years.

We have become so captivated with "outer space" of late that we have tended to ignore the oceans. The testimony of Sumner Pike, former Commissioner of the Atomic Energy Commission, reminded your committee:

"* * * it has become suddenly apparent that the ocean is of the highest importance to national defense, indeed to our survival. It seems unnecessary to emphasize here the possible results of the development of nuclear submarines and guided missiles. My own personal reaction can be phrased briefly: Another nation caught us practically unawares upstairs; for heaven's sake don't let the same thing happen to us down cellar.

"With this problem thrust upon us, we become unhappily aware of the abysmal extent of our ignorance of the ocean in areas where knowledge both wide and accurate seems essential."

Important as is marine research from a military operations standpoint, it will also make possible significant contributions to our knowledge of weather forecasting; economic benefits in the way of food, liquid fuels, and metallic minerals; medical benefits of promise to all mankind.

We in the Great Lakes area are gratified that S. 901 makes specific provision for research in the Great Lakes. Testifying in Detroit before the Senate Select Commitee on National Water Resources, Dean Fontanna of the university had this to say:

"Great Lakes research programs include such matters as determination of currents, study of underlake sediments, the productivity of the waters, water quality, waste dispersion and pollution, shore erosion problems, fish food organisms and the factors regulating their distribution, water transport, lake levels, chemistry and physics of water, and meteorology over the lakes. The results of such research studies can be of major benefit to navigation, to municipalities and industries using the lakes for water supply and waste disposal, to the construction of harbors and channels, to the prevention of beach erosion, to recreation, to fishing, both sport and commercial, and to the training of students in oceanography."

It would be my hope that passage of this bill would make it possible for the United States to get underway with an intensified program. A research ship in the Great Lakes would not only add to our knowledge of those great bodies of water, but we could utilize this "laboratory-sized ocean" for the study of most oceanographic phenomena.

Count on my support in any way possible.

Sincerely,

PHILIP A. HART.

THE UNIVERSITY OF MICHIGAN,
INSTITUTE OF SCIENCE AND TECHNOLOGY,
Ann Arbor, Mich., March 16, 1961.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: I appreciate your invitation to attend the March hearings on S. 901, but since I am unable to accept I will follow your suggestion and submit a statement of my views.

First let me commend you and your committee on a timely and realistic attempt to meet the urgent needs of marine sciences in the United States.

My comments are as follows:

(1) If this legislation is to accomplish the stated objectives, the term "marine sciences" should be interpreted in its broadest connotation—physical, chemical, and biological studies of the earth's surface waters and the atmosphere over them. By definition then this would include the oceans, estauaries, rivers, and lakes. These waters represent a tremendous resource of increasing national importance, and their efficient and effective utilization requires a thorough knowledge of their characteristics.

(2) To advance marine sciences effectively it is essential that the major emphasis be given to basic problems rather than to specific waters or geographical areas. Basic problems such as biological productivity and disposal of radioactive wastes, to mention only a couple of many, can be implemented equally as effectively through studies in fresh water as in marine waters. In fact, fresh waters, because of their small size and ready accessibility, may offer the advantage of economy of time and money in the conduct of research. It is

important to use the waters best suited to solve a particular problem; in one instance it may be the oceans and in another fresh waters.

(3) Scientific personnel qualified to carry out the proposed program in marine sciences must be drawn both from the fields of oceanography and limnology. The objectives, methods, and the equipment of limonology and oceanography are basically the same, and in many instances a person trained in one field eventually works in the other.

(4) The role of our Great Lakes in advancing the marine sciences is noteworthy, and I am pleased with the recognition they have received in your bill. In several respects these large lakes are intermediate in characteristics between the small inland lakes and the oceans, and therefore lend themselves uniquely to certain kinds of investigations. Their evident lacustrine features are (1) possession of both inlets and outlets, (2) typical lake thermal characteristics, and (3) low salt content. Their oceanic characteristics are (1) visible effects of Coriolis force (the apparent tendency of wind-driven surface water to move to the right of the wind direction), (2) distribution of updwellings and sinking according to the relationship of current streamlines and the shore, and (3) the presence of distinct water masses.

The Great Lakes afford the following advantages in the conduct of marine research: (1) Their size and ready accessibility make investigations economical in respect to time and outlay of equipment; (2) most oceanographic phenomena exist in the Great Lakes and in such scale that the lakes may be considered as laboratory-sized oceans; (3) lack of pronounced tides and high salinities make many research problems simpler and more readily solvable in these lakes than in oceans; (4) low electrical conductivity of fresh water and its much less corrosiveness make possible a rapid and economical testing and development of instrumentation; and (5) the existence of scientific research and training centers in the Great Lakes States, such as the Universities of Michigan, Wisconsin, Minnesota, and Ohio State, which contribute to the national effort in marine sciences and are a source of trained personnel.

I look forward to the success of this legislation and greatly appreciate this opportunity to express my views.

Sincerely yours,

David C. Chandler,
Director, Great Lakes Research Division.

Virginia Fisheries Laboratory,
Gloucester Point, Va., March 17, 1961.

Hon. Warren G. Magnuson,
Chairman, Committee on Interstate and Foreign Commerce,
Senate Office Building, Washington, D.C.

Dear Senator Magnuson: * * * I am writing to you in support of S. 901.

I feel that the most important thing is to get the bill passed and, while some few changes would probably be useful, the present bill is a good vehicle for support of marine science.

You may be interested in knowing that this marine laboratory is somewhat unusual among marine laboratories. Though a separate State agency, I make my budget plea directly to the Governor and general assembly, we also have academic affiliations with William and Mary and the Commission of Fisheries of Virginia. The interesting part here is that we are a separate State agency and our budget is not submerged in any overall university budget system or a superagency budget system. This has permitted excellent growth in recent years. I believe that, if possible, the marine science committee your bill proposes should have direct access to the Senate and House Appropriations and Finance Committees—or as direct as possible. This is the best way to assure adequate representation of the cause of marine science where it counts. And the cause of marine science merely deserves adequate representation because next to the land and atmosphere—in the future perhaps above the land—the sea is the most important portion of this planet. It is certainly the largest and it directly affects the economy of all countries and the lives of all people.

As an agency head in State government one perhaps achieves a better understanding of the machinery of government and the difficulties of legislation and financing. One also comes to appreciate the problems that conscientious legislators meet in attempting to achieve support of important projects.

I am enclosing my statement for the record herewith. If I can be of further service please let me know.

For your information I am sending a preliminary copy of a report on this marine laboratory. Though most people do not realize it we are the third largest in biological oceanography on the Atlantic coast with 70 permanent, year-round people and 30 to 40 extra people in summer. This is no summer station, but a full-time marine research plant.

I appreciate your support of marine science and sincerely hope S. 901 will be passed by both Houses of Congress.

With best of luck in your important mission, I am,

Sincerely,

WILLIAM J. HARGIS, Jr., *Director.*

P.S.—By the way, it is not true that a scientific organization must slowly evolve to be a good and effective one. Using care in selection of personnel, assuming they are available, and with a sound organizational framework, a research unit can be built in relatively rapid order—with adequate financing of course.

NATIONAL MARINE CONSULTANTS, INC.,
Santa Barbara, Calif., April 26, 1961.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Commerce,
U.S. Senate, Washington, D.C.

DEAR MR. MAGNUSON: Thank you for your invitation to comment on the bill S. 901, Marine Sciences and Research Act of 1961.

We heartily endorse all aspects of bill S. 901. There is, however, one aspect of oceanography which we as a private organization wish to emphasize and that is the importance of basic research in the field of oceanography not related directly to national defense programs. As private oceanographers, we have had occasion to become familiar with the uses of oceanography (research and applied) in relation to industry as well as governmental activities. In the realm of search for offshore oil resources we have been furnishing industry with daily forecasts of weather and sea states for utilization in their planning and daily operations. We have also made many investigations for private and governmental groups in relation to design and maintenance of harbors, shoreline structures, and off-shore structures. It has been within the framework of these studies that we have realized the dire need for more basic research in all phases of oceanography. One only has to look at the past records of disastrous results to shoreline and offshore structures to realize the great need for applied research in this field.

One immense problem which coastal States must face in the near future is an adequate supply of littoral material (sand) to maintain areas of coastline recreation and structures. The supply of littoral material is directly related to the supply of material transported coastward by rivers, tributaries, and streams. As these sources are curtailed by dams, storm drains projects, and flood control work, the general supply of littoral material to our beaches is gradually but surely being denied. We must know where we are going in this respect. What will happen when the sources are seriously curtailed? At present we are endeavoring to interest certain State and Federal groups to sponsor investigation as to the magnitude of such problems, when they will seriously affect us and procedures in combating the effects.

We bring this to your attention merely to emphasize what far-reaching effects the stepped-up research program will have on the daily existence of the peoples of the United States and of the world, now and in the future.

Yours truly,

NATIONAL MARINE CONSULTANTS, INC.,
By RICHARD C. TIMME.

THE COLLEGE OF MEDICAL EVANGELISTS,
LABORATORY OF NEUROLOGICAL RESEARCH,
Los Angeles, Calif., April 27, 1961.

Senator WARREN G. MAGNUSON,
Senate Building, Washington, D.C.

DEAR SENATOR MAGNUSON: I have read with interest the bill S. 901, Marine Sciences and Research Act of 1961, introduced by yourself before the 87th Congress, February 9, 1961. I feel this bill is of considerable importance to the peoples of our country and the world, and strongly urge its passage.

Our knowledge of the biology and chemistry of marine organisms needs to be implemented, particularly in the field of biochemistry, physiopharmacology and zootoxicology. The progress made in these fields during the past decade has been gratifying but it has been somewhat meager when one considers the advancement made in our knowledge of the biology and chemistry of terrestrial animals.

The group at this laboratory has been actively engaged in projects relating to the physiopharmacological, zootoxicological and chemical properties of certain extracts of marine animals. This work has been supported by the Office of Naval Research, the U.S. Public Health Service and by several private granting agencies.

We are particularly interested in, and encouraged by, the inclusion of paragraph (b), page 27, lines 8 through 15. The potential of marine organisms as a source of chemical, pharmacological and medical usefulness to man is probably greater than most biological scientists have previously thought. During the past 10 years this and other laboratories have isolated a number of important chemical agents having potential usefulness to man in combating diseases, and in adding to our knowledge of the chemistry and biology of marine organisms.

The proposed bill would greatly encourage "research relating to the discovery, determination, production, and extraction of medically and pharmacologically important substances from marine organisms or sea water," and would provide more adequate facilities for biologists and biochemists to conduct projects related to these problems in the marine laboratories of the United States.

Sincerely yours,

FINDLAY E. RUSSELL, M.D.,
Director of Laboratory.

PRATT & WHITNEY CO., INC.,
RESEARCH DEPARTMENT,
West Hartford, Conn., April 20, 1961.

Senator WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: As director of research for the Pratt & Whitney Co., an old New England manufacturing company which is now a division of the Fairbanks Whitney Corp., that is continually diversifying its activities, I would like to give you our opinion of the need for a bill like S. 901.

We believe that the future of mankind depends upon the ability of men to fully exploit and fully utilize the resources of our planet, particularly those of the ocean. Believing this, the Fairbanks Whitney family of companies has begun a series of planned self-supported studies and developments to: economically desalt sea water, extract power from the ocean; explore and exploit the ocean's resources. In these areas of marine and oceanographic activities, there is considerable justification for private enterprise to invest capital of its own, but in many other areas of marine research there is little justification for the investment of private funds and it is in these areas that S. 901 will serve a much needed purpose.

It is our belief, therefore, that S. 901 is a needed act of legislation which is for the good and welfare of the Nation. May we encourage you to continue your well founded efforts on its behalf.

Sincerely yours,

ASA E. SNYDER, *Director of Research.*

SIKORSKY AIRCRAFT,
DIVISION OF UNITED AIRCRAFT CORP.,
Stratford, Conn., April 10, 1961.

Senator WARREN G. MAGNUSON,
Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: Thank you for providing the opportunity for reading and commenting on S. 901, the Marine Sciences and Research Act of 1961. Passage of this bill will go far toward supplying the requisite stimulus to the oceanographic research so vital to our national future. It is particularly interesting to note how much can be accomplished within the framework of the established agencies whose interests have previously been only marginally concerned with such research.

Those of us who are attempting to develop effective undersea equipment have been drastically hampered by lack of knowledge of the environment. Merely to discover what data exists is a time-consuming task, in the absence of a data center. And, frequently, an exhaustive search has disclosed finally that the data are inadequate to permit prediction of equipment performance. This lack of basic information is seriously detrimental to our national defense, and is delaying the realization of accomplishments which would be technologically feasible if environmental factors were more precisely known. For an industry whose primary competence lies in other areas to attempt independent investigations of undersea conditions would be inefficient and unnecessarily costly. It is probable that the climate of broad interests and activity which will be engendered by S. 901 will encourage cooperative endeavors leading to the performance of "applied" research simultaneously with the basic investigations authorized therein.

From many points of view, passage of S. 901 will benefit the Nation and, by the implementation of a training program and stimulating interest on many fronts, we can expect a cumulative accomplishment which will place the United States in the forefront of a most interesting and important field of knowledge.

Very truly yours,

VIRGINIA WITHINGTON,
Supervisor, ASW–USW Res.

CHULALONGKORN LABORATORY,
Ang Sila, Cholburi, Thailand, March 24, 1961.

Hon. WARREN G. MAGNUSON,
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: Your request for a statement on the new sections in S. 901 together with the reply of my coworker, Dr. Philip Helfrich, have been forwarded to me here in Thailand. I certainly support Dr. Helfrich's statement, and I endorse and urge the support of your bill, and I will so write the Hawaiian delegation.

I would like, however, to supplement Dr. Helfrich's statement on two points: First, about the medicinal importance of marine toxins. While our studies and most studies made by others so far have been on the side of "pure" science, and not applied pharmacology and medicine, there are indications that some of these toxins may have considerable medical importance. For example, the studies of Dr. Ross F. Nigrelli and associates indicate that the toxin from sea cucumbers may inhibit cancerous growths, and that the toxin we are studying from tropical fishes may markedly depress the blood pressure.

Second, that some of these studies on toxic marine animals are of international importance. I recently received a letter from Dr. L. C. Dvambez, fisheries officer with the South Pacific Commission, which stated, in part, "The South Pacific Commission is very interested in the whole question of fish poisoning and is anxious to assist in furthering research into this subject. * * *" So, by the inclusion of the new sections in the bill, the Government of the United States will be furthering international relations and helping fulfill its commitments to the South Pacific Commission.

Yours sincerely,

ALBERT H. BANNER,
Professor of Zoology, Director, Hawaii Marine Laboratory, University of Hawaii; on leave.

XV INTERNATIONAL CONGRESS OF LIMNOLOGY,
Madison, Wis., April 6, 1961.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U. S. Senate, Washington, D.C.

DEAR SIR: I have read with interest your recent Senate bill 901. Without some modification, it may not have the impact on oceanography that you envisage. The collaboration from the sister science, limnology, which is most essential to the success of your bill may not be forthcoming owing to omission of small freshwater lakes from the bill's specifications. Permit me to outline for you some of the relationships between lake and ocean studies and to point up some of the advantages of lake research, which can augment our understanding of the oceans:

(1) Lake and ocean science in the United States and Canada is represented by the American Society of Limnology and Oceanography. Its official research publication is Limnology and Oceanography. It would be regrettable if bill 901 were to fractionate this close and natural cooperation of long standing.

(2) Lakes serve as a training site for oceanographers, many of whom began their careers in limnology.

(3) Lakes are miniature oceans and provide models for experimental oceanography. Theories derived from oceanographic data and surveys can be put to test in lakes, whereas the vastness of the ocean places limits on experimentation.

(4) The talent and facilities of the inland universities, where lakes abound, can be brought to bear upon oceanographic problems. Senate bill 901 provides support for research on the Great Lakes, which are sites for investigating oceanlike problems. For this I commend you, but these are too large for many experimental studies, which are needed to elucidate oceanographic problems.

You may be interested to know that a symposium on oceanography designed to enlist cooperation of the Big Ten universities for extended studies in oceanography is scheduled for May in Madison, Wis. In addition, a curriculum in oceanography and limnology is being organized leading to the Ph.D degree at the University of Wisconsin.

(5) The program of the XVth International Congress of Limnology (1962) to be held for the first time in the United States will stress, according to American tradition and leadership, the close interrelationship of limnology and oceanography.

(6) The Ecological Society of America is devoted to a study of interactions in nature. It sponsors collaborative work between aquatic scientists irrespective of salt and fresh water.

I strongly urge you to include in your Senate bill 901 support for scientific research in lakes smaller than the Great Lakes, as well as in oceanography.

Respectfully,

ARTHUR D. HASLER,
Chairman, XV International Congress of Limnology in United States, 1962, President, Ecological Society of America.

COLORADO SCHOOL OF MINES,
DEPARTMENT OF GEOLOGY,
Golden, Colo., March 23, 1961.

Senator JOHN A. CARROLL,
U.S. Senate, Washington, D.C.

DEAR SENATOR CARROLL: We the undersigned individual members of the faculty of the Colorado School of Mines are vitally interested in the future of the marine sciences in the United States. To this end we believe that the passage of legislation such as that introduced in the Senate by Senator Magnuson, of Washingon, as the Marine Sciences and Research Act of 1961 (S. 901) is essential to the continued growth of the marine sciences during the next decade. There is a critical lack of knowledge concerning the oceans, and this lack must be overcome.

Although the State of Colorado is far removed from the oceans, the marine sciences are not without direct application to the problems of the State. Many of the rocks, for instance, which are exposed in Colorado were originally deposited beneath the waters of oceans which covered the continents during past geologic ages. A better knowledge of the processes which are going on in the oceans today will enable us to interpret the conditions under which the rocks of Colorado were laid down. This interpretation in turn can lead to greater development of the mineral resources which are so abundant in our State.

We solicit your support for legislation concerning the marine sciences in the Senate (Congress) of the United States, and ask that you do all within your power to insure its passage.

Sincerely yours,

Robert J. Weimer, Associate Professor; John D. Haun, Associate Professor; Peter C. Badgley, Associate Professor; Warren D. Mateer, Assistant Professor; Harold Bloom, Instructor; Robert H. Hutchinson, Associate Professor; John R. Hayes, Professor; Fred E. Moore, Assistant Professor; Harry C. Kent, Instructor; David W. Trexler, Assistant Professor; Rudy C. Epis, Assistant Professor; Leonid Bryner, Assistant Professor; Donald H. Johnson, Instructor; Lawrence Ogden, Assistant Professor; M. A. Klugman, Assistant Professor; L. W. LeRoy.

(The following comments were received from the Government's agencies:)

EXECUTIVE OFFICE OF THE PRESIDENT,
OFFICE OF CIVIL AND DEFENSE MOBILIZATION,
Washington, D.C., April 4, 1961.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: This is in reply to your request for a report on S. 901, 87th Congress, a bill which would be called the Marine Science and Research Act of 1961.

While we favor expanded efforts in the field of oceanography, the enactment of legislation to accomplish this purpose would appear to be unnecessary in view of the coordinated and intensified national program for oceanography recommended by the President in recent messages to the Senate and the House.

The Bureau of the Budget advises that it has no objection to the submission of this report from the standpoint of the administration's program.

Sincerely,

FRANK B. ELLIS, *Director.*

U.S. DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D.C., April 24, 1961.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: Your committee has requested a report on S. 901, a bill to advance the marine sciences, to establish a comprehensive 10-year program of oceanographic research and surveys, to promote commerce and navigation, to secure the national defense, to expand ocean, coastal, and Great Lakes resources, to authorize the construction of research and survey ships and laboratory facilities, to expedite oceanographic instrumentation, to assure systematic studies of effects of radioactive materials in marine environments, to enhance the public health and general welfare, and for other purposes.

We concur in the general object of this bill; however, notwithstanding our considerable interest in oceanographic research, we recommend that no action be taken on this bill for two principal reasons hereafter stated.

First, as stated in our report of May 16, 1960, to your committee, concerning S. 2692 of the 86th Congress, this Department is already engaged in carrying out certain types of oceanographic research. Our report stated also that while this Department concurred in the objectives of such proposal, we have authority to carry out such research and did not believe enactment of the proposed legislation was necessary. We believe the enactment of S. 901 is unnecessary also for the same reasons and might inhibit the flexibility of oceanographic research programs.

Secondly, a coordinated and intensified national program for oceanography has been recommended by the President in his recent messages to the Senate and House. We believe that, if adopted, this program would provide a balanced and effective use of overall resources available for oceanography.

For the foregoing reasons, we believe that action on S. 901 would be unnecessary at present. We wish to emphasize, however, our great interest in the subject of oceanography and our desire that this form of research proceed efficiently and advantageously in the national interest. Four bureaus of this Department, our Bureau of Commercial Fisheries, our Bureau of Sport Fisheries and Wildlife, our Bureau of Mines, and the Geological Survey are directly concerned with the field of oceanography. We are prepared to contribute our share, to the extent that funds may be appropriated, toward accomplishment of the general objective of oceanographic research.

The Bureau of the Budget has advised that there is no objection to the presentation of this report from the standpoint of the administration's program.

Sincerely yours,

JOHN W. KELLY,
Assistant Secretary of the Interior.

NATIONAL SCIENCE FOUNDATION,
OFFICE OF THE DIRECTOR,
Washington, D.C., April 27, 1961.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

MY DEAR SENATOR MAGNUSON: This is in further reply to your recent request for the comments of the National Science Foundation on S. 901, the Marine Sciences and Research Act of 1961.

We are in complete accord with the objective of S. 901 which is aimed at assuring that the United States has a strong national oceanographic program. In this connection, as you know, the President, on March 29, 1961, transmitted to the Congress his recommendations with respect to the appropriation of funds for fiscal year 1962 to carry on the Federal effort in oceanography. The total amount requested for all Federal agencies is approximately $97.5 million. Of this amount, nearly $20 million is for the programs of the National Science Foundation. We believe that if the amounts requested by the President for the foundation for fiscal year 1962 for support of oceanographic research activities are provided by the Congress, they will enable the Federal Government to continue to strengthen its oceanographic research activities in a sound manner.

With respect to the National Science Foundation, in addition to authorization of appropriations, S. 901 would direct the establishment of a Division of Marine Sciences in the foundation, with a divisional committee consisting of representatives of various of the Federal agencies engaged in oceanographic research activities, together with six non-Federal scientists designated by the National Academy of Sciences-National Research Council. When the National Science Foundation was established, the Congress wisely provided for divisions concerned with general branches of science as, for example, the mathematical, physical, and engineering sciences and the biological and medical sciences. After careful consideration of the matter, we have concluded that establishment of divisions on the basis suggested in the bill would not be as sound an arrangement and could lead to distortion and overlap in administration. Then too, there would seem to be equally appropriate reasons for establishing other divisions in the foundation for particular scientific disciplines which could lead to further organizational difficulties. At present, the foundation is supporting oceanographic research activities through its existing divisions among which there is extremely close cooperation and coordination. To aid in carryng out these responsibilities, the foundation has a full-time oceanographer on its staff as well as a special consultant on a full-time basis in the field of biological oceanography. Our organizational arrangements for handling cross-disciplinary fields such as oceanography is a matter to which we are paying close attention, however, and we will not hesitate to change them as circumstances warrant.

One of the primary objectives of S. 901 is to assure that there is a continuing national policy and program for carrying out the Nation's oceanographic effort. Coordination of the activities of the Federal agencies in this area is presently the responsibility of the Federal Council for Science and Technology, whose Chairman is the Special Assistant to the President for Science and Technology. It is, of course, important, in the carrying out of the national program, that full information be available with respect to the status of the national effort, both public and private, and the needs in particular areas of this endeavor. The National Science Foundation, in carrying on its support of basic research in oceanography and related fields, keeps in close touch with oceanographic research activities throughout the world. In this connection, we are planning to issue, at appropriate intervals, reports on the status of oceanographic research together with assessments, as appropriate, of national needs in this area.

We are deeply mindful of the importance of oceanographic research to the national welfare and are prepared to cooperate in any way possible to assure that the oceanographic effort of the United States is second to none.

The Bureau of the Budget has advised us it has no objection to the submission of this report.

Sincerely yours,

Alan T. Waterman, *Director.*

Department of the Navy,
Office of the Secretary,
Washington, D.C., May 5, 1961.

Hon. Warren G. Magnuson,
Chairman, Committee on Commerce,
U.S. Senate, Washington, D.C.

My Dear Mr. Chairman: Reference is made to your request for the views of the Department of Defense on S. 1189, a bill to amend title 14 of the United States Code in order to authorize the Coast Guard to carry on certain oceanographic research.

The purpose of this bill is to expand the duties of the Coast Guard to include collecting, analyzing, and evaluating scientific data and operating oceanographic ships. The legislation establishing the Coast Guard did not permit it to perform any oceanographic work. S. 1189 would correct this.

Coast Guard weather ships, ice breakers, ice patrol craft, and other ships operate in waters of great oceanographic interest. There is also a considerable capability vested in the Coast Guard plant of ships, stations, and towers that would enable them to make a significant contribution to the national oceanographic program.

The authority that would be provided by this bill would complement the authority available to this department and other agencies for carrying out oceanographic activities. In this connection, it should be noted that there was recently established the National Oceanographic Data Center as a central clearinghouse for the exchange of data gathered by many sources for the benefit of all users.

The Department of Defense supports enactment of S. 1189.

This report has been coordinated within the Department of Defense in accordance with procedures prescribed by the Secretary of Defense.

The Bureau of the Budget advises that, from the standpoint of the administration's program, there is no objection to the presentation of this report for the consideration of the committee.

Sincerely yours,

Robert E. M. Ward,
Rear Admiral, U.S. Navy,
Chief of Legislative Affairs
(For the Secretary of the Navy).

Department of State,
Washington, D.C., April 4, 1961.

Hon. Warren G. Magnuson,
U.S. Senate.

Dear Senator Magnuson: In your letter to the Secretary of February 13, 1961, you asked for comments concerning S. 901, 87th Congress, 1st session, introduced by you.

International cooperation has always been a factor in oceanography and marine biological studies. Throughout the history of the United States the Department of State has had and will continue to have an interest in securing the cooperation of other countries for expeditions and surveys in international and territorial waters. These expeditions may be of private origin, they may be undertaken by Federal agencies, by individual States or they may be a combination of both.

The United States provides substantial encouragement and support to international organizations having science programs. They can include nongovernmental agencies such as the International Council for the Exploration of the Sea, the International Association of Physical Oceanography, the International Council of Scientific Unions, as well as intergovernmental organizations of which the United States is a member, such as the International Atomic Energy Agency, the Work Meteorological Organization, and the Food and Agricultural Organization. It is desirable both for foreign relations and for the advancement of knowledge which will be of benefit to mankind that the U.S. efforts in marine science be strengthened. Such strengthening will be achieved by adoption of the expanded national program in oceanography recommended by the President in his recent messages to the Senate and House.

The Bureau of the Budget advises that, from the standpoint of the administration's program, there is no objection to the presentation of this report for the consideration of the committee.

Sincerely yours,

BROOKS HAYS,
Assistant Secretary
(For the Secretary of State.)

THE SECRETARY OF THE TREASURY,
Washington, April 14, 1961.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

MY DEAR MR. CHAIRMAN: Reference is made to your request for the views of this Department on S. 901, to establish a program of oceanographic research.

The Coast Guard presently has limited authority in the field of oceanography, such as providing meteorological services from floating ocean stations and studying ice and current conditions in the North Atlantic Ocean (14 U.S.C. 90; 46 U.S.C. 738a(a)). Under its limited authority, the Coast Guard has been conducting oceanographic work on its eastern seaboard lightships and has been taking soundings and bathy thermograph readings.

The President, in his letter to the President of the Senate dated March 29, 1961, relating to a national oceanographic program, recommended that statutory limitations restricting participation by the Coast Guard in oceanographic research be removed. The Coast Guard, with its fleet of vessels and other units, is particularly well adapted to assist in this scientific endeavor. General statutory sanction to conduct and engage in oceanographic programs would make possible a greater contribution by the Coast Guard in that activity.

There is also pending before your committee S. 1189, which is designed to give the Coast Guard such general authority to conduct oceanographic research. The Department has submitted a report on that bill which recommended its enactment with certain amendments. Favorable consideration of that proposal would provide the Coast Guard adequate authority in the oceanographic field, and the enactment of S. 901 is considered unnecessary.

The Bureau of the Budget has advised that there is no objection to the submission of this report from the standpoint of the administration's program.

Very truly yours,

A. GIMORE FLUES,
Acting Secretary of the Treasury.

COMPTROLLER GENERAL OF THE UNITED STATES,
Washington, May 11, 1961.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Commerce,
U.S. Senate.

DEAR MR. CHAIRMAN: Further reference is made to your letter of February 13, 1961, acknowledged on February 14, requesting the comments of the General Accounting Office concerning S. 901, 87th Congress, 1st session, entitled "A bill to advance the marine sciences, to establish a comprehensive 10-year program of oceanographic research and surveys, to promote commerce and navigation, to secure the national defense, to expand ocean, coastal, and Great Lakes resources, to authorize the construction of research and survey ships and laboratory facilities, to expedite oceanographic instrumentation, to assure systematic studies of effects of radioactive materials in marine environments, to enhance the public health and general welfare, and for other purposes."

The general purpose of S. 901 is a matter of policy for the determination of the Congress. However, in the consideration of the bill, we recommend the following corrections and clarifications:

We believe that because of the number of agencies and the amount of funds involved in carrying out the purposes of the bill, it might be well to consider the vesting of specific authority for controlling and coordinating the oceanographic programs of the several agencies in one organization to prevent duplication of effort and to assure the most effective and economical operation of the program.

Section 8(a) of the proposed legislation authorizes appropriations to the Coast and Geodetic Survey as are necessary for the construction of eight survey ships. The Coast and Geodetic Survey has requested funds in the amount of $9,425,000 to be appropriated in fiscal year 1962 for one oceanographic surveying vessel under its existing ship construction legislation (33 U.S.C. 883i). The Bureau has also proposed in its 1962 budget justifications a program for construction of seven additional oceanographic ships and it expects to request the necessary funds during fiscal years 1963–65. It is not clear whether the eight ships required to be constructed by section 8(a) of the bill are the same as or in addition to the eight ships included in the Coast and Geodetic Survey's proposed oceanographic program.

Section 8(b) does not place any limitation on the cost of operating new Coast and Geodetic Survey ships, while a 10-year limitation is imposed on the National Science Foundation by section 4(b) and annual limitations are imposed on the Bureau of Commercial Fisheries by section 6(b) and on the Navy by section 14. We recommend clarification on this point.

Section 8(i) imposes a qualification that any person receiving training or education at the expense of the Department of Commerce must agree to continue employment in the Department for a period not less than 3 years for each year of training received. However, the bill does not contain a similar qualification for training and educational programs of other agencies. In view thereof, and since we are unable to ascertain whether such a limitation was intended for other agencies, we recommend that this phase of the matter be clarified.

By making oceanographic research one of the primary duties of the Coast Guard, under this bill, it appears that under the authority of 14 U.S.C. 92(d) the Secretary of the Treasury could then construct vessels for the exclusive purpose of oceanographic research. It is not clear, however, whether the Coast Guard was intended to have this additional ship construction authority since the bill would place a monetary limitation on the amount of scientific equipment that may be installed on each Coast Guard vessel assigned oceanographic research duties. Accordingly, we recommend that the bill clearly indicate whether this additional ship construction authority is intended to be granted to the Coast Guard.

Since section 10(d) does not appear to be related to the appropriations referred to in the preceding paragraphs of this section, we suggest that section 10(d) be redesignated as section 9(e).

On page 34, line 4, the bill reads "(a) Provide funds, by contract or otherwise * * *." We believe the word "grant" should be substituted for "otherwise" because this would make the provision more specific and would conform with the wording on line 23 of page 34 and in the general provisions on line 9 of page 54.

We suggest that the term "operating costs" on page 39, line 17, be clarified to indicate the actual costs intended to be included. We have been advised informally by the Department of the Navy that they overlooked this provision in their review of the prior bill and that careful consideration would be given thereto in their study of the present bill. We observe that operating costs of ships are also referred to in various other sections of the bill without indication of the costs intended to be included, e.g., line 23, page 8; lines 15 and 17, page 15; and line 10, page 24.

The general provisions on page 54 provide in section 21(c) that all agreements for grants in excess of $50,000 shall contain a provision that the General Accounting Office shall have the right to examine the pertinent records of the grantee relating to the grant. While this provision is in accord with our recommendation of November 17, 1959, to your committee concerning S. 2692, 86th Congress, we now believe that it would be more desirable not to place a monetary limit upon our authority with respect to the review of such grants. Furthermore, in addition to grants, it is observed that the bill also contains authority for entering into contracts with qualified scientists, research laboratories, research organizations, or educational institutions to undertake basic and applied research studies and experiments in furtherance of the purposes of the act. In view thereof, we recommend that section 21(c) of the bill be amended to read as follows:

"(c) The Comptroller General of the United States or his duly authorized representatives shall, until the expiration of three years after the last payment to such grantee or contractor, have access to and the right to examine any books, documents, papers and records of any grantee, contractor or subcontractor engaged in the performance of any grant, contract or subcontract executed for the purpose of carrying out the provisions of this Act, and a provision to that effect shall be included in each such grant agreement, contract and related subcontracts."

The reference in line 16, page 20 of the bill, to "The Act of June 12, 1895," should read "The Act of January 12, 1895," and the sentence beginning on line 6, page 48, is incomplete, and apparently the phrase "to carry out" should be inserted on line 8 of the same page.

The bill contemplates that a considerable amount of basic and applied research will be done. Therefore, since it appears that these costs will be financed in whole or in part by grants, contracts, or otherwise, and that patentable discoveries may be expected to result from such research, we suggest that the committee may wish to consider the advisability of providing a policy statement concerning such patentable discoveries, i.e., whether or not patent rights are to vest in the Government.

Since the phrase "oceanographic research" appearing in line 18 of page 46 of the bill appears not to be properly applicable in the first sentence of section 81, title 14 of the United States Code, following the word "aircraft," we recommend clarification with respect to the intended use of this phrase. We also suggest a clarification of the amending language indicated in line 1, page 47 of the bill, to be added to the foregoing section 81, so as to indicate whether the items mentioned therein are intended to constitute aids to navigation.

Sincerely yours,

JOSEPH CAMPBELL,
Comptroller General of the United States.

U.S. ATOMIC ENERGY COMMISSION,
Washington, D.C., May 11, 1961.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U.S. Senate.

DEAR SENATOR MAGNUSON: The Atomic Energy Commission is pleased to have this opportunity to comment on S. 901, a bill to advance the marine sciences, to establish a comprehensive 10-year program of oceanographic research and surveys, and to achieve other worthwhile purposes relating to marine environments.

While the Commission is in accord with the purposes and intent of the proposed legislation, we believe enactment of the bill unnecessary. This opinion is based on our belief that the balanced and flexible overall national program of oceanography recommended by the President in his letter of March 29, 1961, to the President of the Senate will provide for the best use of resources available for oceanography in general and those available to the Commission in particular for discharging its responsibilities in the field of oceanography.

With respect to sections 9(c), 11, and 12 of the proposed legislation wherein certain studies and regulatory programs relating to radioactive waste disposal are authorized, the Atomic Energy Commission has, under the provisions of the Atomic Energy Act of 1954, as amended, authority and responsibility for both the research and regulating aspects of the spheres of activity covered by the aforementioned sections of this bill. Furthermore, in fulfilling these responsibilities, the Commission has put into effect an extensive regulatory and research and development program in this field which will extend beyond the 10-year limit contemplated by S. 901.

We have been advised by the Bureau of the Budget that there is no objection to the transmission of this report from the standpoint of the administration's program.

Sincerely yours,

JOHN S. GRAHAM,
Acting Chairman.

MARINE SCIENCE

TUESDAY, MAY 2, 1961

U.S. Senate,
Senate Committee on Commerce,
Washington, D.C.

The committee met, pursuant to notice, at 10:15 a.m., in room 5110, New Senate Office Building, the Honorable Warren G. Magnuson, chairman of the committee, presiding.

The Chairman. The committee will come to order.

Several of the Senators are on their way or in the other room. We have a long agenda this morning.

(S. 1189 follows:)

[S. 1189, 87th Cong., 1st sess.]

A BILL To amend title 14 of the United States Code in order to authorize the Coast Guard to carry on certain oceanographic research.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That title 14 of the United States Code, relating to the Coast Guard, is amended by inserting at the end of chapter 5 the following new section:

"§ 94. Oceanographic research

"The Coast Guard may conduct such oceanographic research, use such equipment or instruments, and collect and analyze such oceanographic data, in cooperation with other agencies of the Government or not, as the Secretary determines to be in the national interest."

Sec. 2. The analysis of chapter 5 of title 14 of the United States Code is amended by inserting at the end thereof the following:

"9. Oceanographic research."

The Chairman. The chairman first wants to call Admiral Hirshfield of the Coast Guard, who is here.

Admiral, could you come forward?

The committee has held a long series of hearings on S. 901, the oceanography bill, which were conducted jointly with hearings on S. 1189, to authorize the Coast Guard to conduct certain oceanographic research. Of course, the Coast Guard has a very deep interest in this whole matter. The Treasury has sent up reports on both S. 901 and S. 1189 which we will place in the record, but before we close the hearings we did want to have a statement from the Coast Guard, and I also will put in the record my preliminary statement.

Admiral, you sent up to the committee, after the White House message on the bill, a breakdown and a budgetary summary and information regarding Coast Guard vessels and operations and all your activities in the field of oceanography.

Now, I am not so sure this might not be the substance of your testimony. So, we will put that in the record in full along with the Presidential message and the Treasury reports, my statement, and any other matter the Coast Guard wishes to add to it.

We will leave the record open 3 or 4 days—you might want to send a further brief statement enlarging a little on this report—but it is quite complete. If we could get in this week sometime we could close the hearings and get the bill on its way.

Admiral HIRSHFIELD. Yes, sir, certainly.

The CHAIRMAN. We thank you very much for that.

(The documents follow:)

Members of this committee have long been aware that the U.S. Coast Guard has a tremendous potential for acquiring much valuable oceanographic data quickly and at minimum cost, utilizing vessels of its existing fleet.

The Coast Guard also has been cognizant of this as indicated in a report prepared last fall at my request for the committee and which will be included in today's hearing record.

The report lists the classes of ships operated by the Coast Guard and the oceans or areas to which they are assigned and analyzes the capabilities of each class for scientific research.

Statutory restrictions have prevented the Coast Guard from undertaking independent oceanographic research except on a very limited scale and that principally in connection with the Ice Patrol.

To correct this inadequacy S. 901, to authorize a national oceanographic program, includes the Coast Guard under section 17 and 18 of the bill, which was introduced on February 9.

On March 2, I introduced S. 1189 which is similar in intent to sections 17 and 18 of S. 901 but which is applicable only to the Coast Guard and not to other agencies or services of our Government.

In my remarks to the Senate at the time I introduced S. 1189 I included a summary table of Coast Guard vessels excerpted from the report referred to above.

On March 29, Preseident Kennedy, in a letter to Vice President Johnson stated as follows, and I quote:

"At present, the Coast Guard enabling legislation limits the extent to which the Coast Guard can engage in scientific research. Only the International Ice Patrol is authorized to make such studies. I recommend that the statutory limitations restricting the participation by the Coast Guard in oceanographic research be removed. With ocean weather stations, deep sea thermometers, and other data collection devices, our Coast Guard can make a valuable contribution to the oceanographic program."

In my opinion the Coast Guard should be freed from its present statutory anchor chains to make the contributions to our scientific knowledge of the oceans of which its officers and personnel are so eminently capable.

STATEMENT OF VICE ADM. JAMES A. HIRSHFIELD, USCG, ACTING COMMANDANT, U.S. COAST GUARD, ON S. 1189 BEFORE THE SENATE COMMITTEE ON COMMERCE

Mr. Chairman and members of the committee, I appreciate the opportunity to appear before you during your consideration of S. 1189.

This proposed legislation to authorize the Coast Guard to carry on oceanographic research, is in consonance with the expressed desires of the President as regards the national oceanographic program. In his letter to the Congress dated March 29, 1961, the President recommended that statutory limitations which now restrict Coast Gaurd participation in oceanographic research be removed.

I feel that the enactment of S. 1189 or its equivalent, will grant the Coast Guard general authority in this field and will permit the greater utilization of the Coast Guard in the national oceanographic effort. In this connection, Mr. Chairman, I refer to the Commandant's letter to you dated November 14, 1960, wherein was furnished a complete report concerning the activities and potential of the Coast Guard in the field of oceanography. I do not believe it necessary at this time to refer to the detailed information contained therein.

S. 1189 proposes that title 14, United States Code, be amended by inserting a new section 94 at the end of chapter 5. In view of the fact that section 2 of title 14, United States Code, sets forth the primary duties of the Coast Guard, I feel that the desired objective of this bill would be better attained if this section were amended in lieu of introduction of a new section 94. If this were done, the Coast Guard would have the broadest possible authority in oceanography, thus enabling us to carry out any assigned tasks within our capabilities. In this connection, I refer to the language change recommended in the Department of the Treasury letter dated April 14, 1961.

In summation, may I say that as an agency whose prime responsibilities rest in the maritime field, the Coast Guard completely supports the objective of S. 1189.

INFORMATION REGARDING COAST GUARD VESSELS AND OPERATIONS IN ACTIVITIES RELATING TO FIELDS OF OCEANOGRAPHY FROM THE COMMANDANT, U.S. COAST GUARD

1. A SUMMARY OF COAST GUARD VESSELS AND OPERATIONS WITH REGARD TO OCEANOGRAPHIC RESEARCH

Description	Atlantic coast	Pacific coast	Great Lakes	Hawaiian and Pacific areas	Alaska area	Total number
Large cutters (over 200 feet)	24	8	0	4	0	36
Icebreakers	2	1	1	0	1	5
Patrol craft (100 to 200 feet)	17	6	0	0	0	23
Oceangoing tugs	4	4	0	0	0	8
Buoy tenders (over 150 feet)	30	6	7	5	7	55
Buoy tenders (under 150 feet)	33	6	17	0	2	58
Patrol boats and harbor tugs (under 110 feet)	80	33	5	1	6	125
Lightships	23	7	1	0	0	31
Miscellaneous craft	4	0	0	2	0	6

(*a*) *Large cutters* (*36 total*)

There are three classes of these vessels: twelve 255-foot class completed at the end of World War II; six 327-foot class constructed in the mid-1930's and eighteen 311-foot former Navy seaplane tenders. Thirty-two of the thirty-six are assigned to ocean station duties. As such the oceanographic activities of these vessels are discussed under that category.

The 311-foot class are of the same class as the U.S. Navy oceanographic vessels *San Pablo* and *Rehobeth*, the Coast and Geodetic Survey's *Pioneer* and the *J. W. Gibbs* operated by the Navy for Columbia University.

(*b*) *Icebreakers* (*total 5*)

This group includes the three *Wind* class cutters used in Polar operations, the *Mackinaw* on the Great Lakes and the *Storis* used for Alaskan and Bering Sea patrols.

The *Wind* class breakers have been active in oceanographic research since 1946. These vessels have oceanographic laboratories and hydrographic winches permanently on board. The oceanographic programs usually have been conducted in conjunction with the annual Arctic and Antarctic Navy operations in which these vessels have participated. It is reasonable to assume that about one-third of all oceanographic observations from surface vessels in the Arctic and Antarctic have been conducted by these vessels.

The USCGC *Northwind* based in Seattle currently is conducting an unprecedented fall oceanographic cruise of the Bering, Beaufort, and Chukchi Seas. No prior observations of this type exist from these critical waters for the fall season. The survey is being conducted in cooperation with the U.S. Navy and the University of Washington.

The *Northwind* and the *Storis* generally comprise the annual Bering Sea patrol. In its 75-year history the Bering Sea patrol has made vast contributions to the sciences of Alaskan waters. A primary duty of the patrol includes the enforcement of laws and treaties for the conservation of marine life in Pacific-Arctic waters. In this capacity the related field of oceanographic research is not overlooked.

(c) *Patrol craft, 100- to 200-foot* (*total 23*)

This group includes the 125- and 165-foot classes constructed in the 1920's and 1930's respectively. These vessels primarily are delegated to coastal search and rescue duties. The cutters assigned along the Gulf of Mexico patrol the U.S. fishing fleet on the productive shrimp grounds of the Campeche Banks. In this capacity, these ships conduct sounding surveys and have contributed to the bathymetry of these fishing grounds.

Except for occasional water pollution and radioactive waste disposal studies, these vessels have not participated in additional oceanographic activities. Their present assignments and workload would preclude an oceanographic program except possibly as part of the Campeche patrol.

It should be noted that three ships of this type have served for many years as important oceanographic vessels. These are the cutters *Marion* and *General Green* assigned as the ice patrol oceanographic vessels from 1926 to 1940 and made the pioneering oceanographic surveys of the Labrador Sea and Baffin Bay which still stand as first-rate achievements. A former cutter, the *Crawford*, has been one of the Woods Hole Oceanographic Institution's most active research vessels for nearly a decade.

(d) *Oceangoing tugs* (*total 8*)

This group includes former Navy vessels of the ARS (213 feet), ATF (206 feet) and ATA (143 feet) classes. The Woods Hole Oceanographic Institution vessel *Chain* and Scripps Institution *Argo, Horizon and Spencer F. Baird* also are of these classes.

The Coast Guard primarily uses its tugs for ocean rescue duties. Two of this type annually are assigned as standby ice patrol cutters and in years of severe iceberg hazard patrol the Grand Banks of Newfoundland. A noteworthy contribution was made by one of these ships during the 1959 ice patrol season when it conducted a study of radar detection of ice at sea.

In June 1960, one of these vessels in cooperation with the National Institutes of Health made a significant oceanographic achievement in establishing and retrieving a deep sea mooring in the study of radioactive waste disposal.

No special oceanographic instrumentation currently exists or is provided for the tugs. The nature and workload of the normal duties of these ships would prohibit any but a limited oceanographic project.

The planned replacements for the tugs are included in 200-foot medium endurance vessels planning noted under the "Patrol craft" heading.

(c) *Buoy tenders over 150-feet* (*total 55*)

These are the oceangoing vessels which service offshore and major aids to navigation. The dominant type of this group is the 180-foot class which numbers 38 ships. Two of these vessels in cooperation with the U.S. Navy participated in the first U.S. transit of the Northwest Passage in 1958. Others have conducted significant hydrographic surveying and mapping of Greenland and arctic waters.

The highly successful meteorological and oceanographic automatic buoy in the Gulf of Mexico was established as a cooperative effort with the U.S. Navy and U.S. Weather Bureau and is serviced by a 180-foot Coast Guard tender. It is reasonable to assume that since these are the only U.S. vessels capable of working buoys at sea, the future plans for increased use of oceanographic buoy systems will call upon the services of this type of vessel.

One of the 180-foot class is especially assigned as the oceanographic vessel for the International Ice Patrol. Its activity is later discussed. This ship has proven excellent for this purpose and can maintain progress in a survey during heavy weather.

The Coast Guard operates five 189-foot tender class cutters which are sister ships to the *Yamacraw* (transferred to U.S. Navy, 1959) which conducted oceanographic research for the Woods Hole Oceanographic Institution and is now engaged in research for the Navy. This class is shorter ranged, has no ice reinforcing, and is less suitable for oceanographic investigations than the 180-foot class.

The normal workload and operation of the buoy tenders in aids to navigation precludes any but the most limited oceanographic effort except as especially assigned such as the case of the arctic cruises and the Ice Patrol oceanographic vessel.

(*f*) *Buoy tenders under 150 feet* (*total 58*)

This general classification includes varied types of tenders designed for river, lake, and inland waterways. Few have oceangoing or extended cruising characteristics.

The buoy-handling arrangements and gear on tenders would be considered desirable in certain kinds of marine investigations but the normal workload in aids-to-navigation operations prohibits consideration of oceaographic research in any but the most limited concepts.

(*g*) *Patrol boats and harbor tugs under 110 feet* (*total 125*)

This category includes eighteen 110-foot harbor tugs employed for customs boarding and coastal rescue. Many of the tugs have icebreaking characteristics and extended cruising range which can be considered feasible for limited marine research activities. During World War II, several of these vessels did significant hydrographic surveys and mapping in Greenland waters. Their present workload precludes consideration in routine oceanographic work.

The majority of this category constitute the 95- and 83-foot (being replaced by 82-foot patrol boats). These are used for short-range search and rescue, port security, law enforcement, and patroling marine regattas. The design, accommodations, and propulsion plants would eliminate these types of boats as suitable research craft.

(*h*) *Lightships* (*total 31*)

Lightships provide a medium for marine research which is uniquely valuable. Lightships currently engage in projects as can be established in cooperation with the Coast and Geodetic Survey, the Bureau of Commercial Fisheries and various private nonprofit marine research organizations. Such projects include water sample collections, bathythermograph and drift bottle casts.

The participation by a lightship in a program must be at no cost to the Coast Guard and not interfere with the primary mission of the unit. This imposes a burden on the originating agency whereby the full potential of the ship is not realized. While this appears, at first, to be an unrealistic approach on the part of the Coast Guard, the service's funds cannot sustain the cost of a full-scale participation for which no statutory authority or budget exists. Present cooperation, although still considerable, must be conducted in this manner. In reality the Coast Guard does absorb some amount of cost and effort in order to achieve the present state of cooperation.

Plans to replace certain of the light vessels with offshore towers and the embodying oceanographic capability are discussed in another section.

(*i*) *Miscellaneous craft* (*total six*)

These vessels are training and cargo type ships which have specialized assignments normally not commensurate with oceanographic research.

2. ICE PATROL OCEANOGRAPHY

The Coast Guard has conducted oceanographic research in connection with the International Ice Patrol since 1914. This is presently done in accordance with the International Convention for the Safety of Life at Sea and by authority of 46 U.S.C. 738. The Coast Guard is justly proud of its record in this field. It was the first agency to routinely send its officers for graduate training in oceanography. The Ice Patrol first used the salinometer in 1926 and has done so continuously. In cooperation with the Woods Hole Oceanographic Institution, such new instruments as the GEK current meter, airborne radiation thermometer, extra deep and electronic bathythermographs were first tested and carried by Ice Patrol aircraft and ships.

The purpose of the Ice Patrol oceanographic program is to afford an understanding of the ocean currents of the Grand Banks and Labrador Sea whereby the drift of icebergs can be foretold and accomplish a more effective use of ships and aircraft as well as assuring the utmost safety for ships traversing the area. In the pursuit of this program the contribution to marine science has been considerable.

The Coast Guard Oceanographic Unit is responsible for the conduct of the program. This unit consists of one military and two civilian oceanographers. Four enlisted personnel serve as especially trained oceanographic technicians. Laboratory work is done at the Woods Hole Oceanographic Institution and seasonal field work is performed on the 180-foot tender class cutter *Evergreen*.

This ship is configured for the routine collection of oceanographic data; two modern deep sea hydrographic winches, Nansen bottles, reversing thermometers, an electric salinity bridge, GEK current meter and an air-conditioned laboratory comprise the basic outfit. The work primarily is physical oceanography but biological, chemical, and meteorological studies have been conducted on a cooperative basis. The data collected by the Ice Patrol are subjected to the most rigid standards of quality control and are universally accepted and held in the highest repute.

3. ACTIVITIES OF OCEAN STATION VESSELS RELATING TO OCEANOGRAPHIC RESEARCH

Coast Guard Ocean Station vessels occupying six weather stations in the Atlantic and Pacific Oceans year round represent a research potential significant to even a casual observer. Since the establishment of the ocean stations on a peacetime footing in 1946, many oceanographic programs have been and are continuously being conducted. These include bathymetric surveys, drift bottle casts, sea and swell observations, plankton hauls, bird and seal surveys, bathythermograph observations, air and water samples. In June 1960, a scientist from Scripps Institution of Oceanography participated in a test oceanographic project on board USCGC *Ponchartrain* on ocean station November in the Pacific. The results were most promising. In July 1960, oceanographers from the U.S. Navy Hydrographic Office conducted special bathythermograph studies from USCGC *Chincoteague* on station Charlie in the Atlantic. As a result, the Navy is considering a request for increased Coast Guard weather ship participation in an oceanwide data reporting system.

Despite the continuing productivity of the weather ships, the overall scope of research accomplished over the past 15 years doubtless is inadequate as viewed by the oceanographic community. Scientific investigations by Coast Guard ships are conducted on a cooperative basis with the cooperating agency initiating the request and providing the instrumentation. Further, such work must be accomplished at no cost to the Coast Guard whose statutory authority does not permit budgeting for oceanographic research except in direct support of the Ice Patrol. As a consequence, weather ships are not equipped with any instruments for research in the fields of oceanography except as occasionally provided by a cooperating agency. Navy owned bathythermographs are carried and utilized by ocean station vessels.

4. PRESENT OR PAST ACTIVITIES OF COAST GUARD VESSELS

Much of sections 1–3 has already discussed this aspect and this will serve to review and summarize the foregoing.

The principal areas of Coast Guard accomplishment in the fields of oceanography have been in the course of the International Ice Patrol and the Bering Sea Patrol where under existing law, Coast Guard operations can be closely related to scientific investigations. The USCGC *Marion* expedition in 1928 conducted the first U.S. oceanographic surveys of the Atlantic Arctic. In 1937, the USCGC *Chelan* oceanographic cruise of the Bering and Chukchi Seas was the first such cruise into these waters. The present cruise of the *Northwind* continues this role and in the Northwest Atlantic Ocean the Ice Patrol to date has occupied over 7,600 oceanographic stations since commencement of the program in 1914. In 1959, Coast Guard vessels made over 24,191 bathythermograph readings and compiled 359,135 miles of bathymetric soundings for the Hydrographic Office.

As a part of its law enforcement duties, Coast Guard ships have participated in pollution and radioactive waste disposal studies.

Excluding the foregoing, the majority of the oceanographic research participated in by the Coast Guard is under the authority of the general heading "Cooperation With Other Agencies" in the Coast Guard's statutory mission. Accomplishments are long and varied. The more important ones have been included in the various sections of this report.

5. LIGHTSHIP REPLACEMENT PROGRAM

Present plans for the replacement of lightships with offshore towers call for the erection of two towers per year for from 7 to 9 years. Eighteen of the present 24 light vessel locations are considered economical for replacement. The first of the towers is to be in Buzzards Bay, Mass., and is well along in the design stage. The tower is planned to be operational by summer 1961.

The oceanographic potential of these towers is obvious. An oceanographic facility is being incorporated into the basic design. This will include a platform and a triple cable hoist for instrument array. Wave measuring and tide gage recorders will be on one of the tower legs. Interior space will be provided for instrument laboratory and quarters for transient maintenance personnel. Basic instrumentaiton is being done in cooperation with the Beach Erosion Board, Coast and Geodetic Survey and the Hydrographic Office.

Future towers will be instrumented based on experience gained from the first.

THE SECRETARY OF THE TREASURY,
Washington, April 14, 1961.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
U.S. Senate, Washington, D.C.

MY DEAR MR. CHAIRMAN: Reference is made to your request for the views of this Department on S. 1189, to amend title 14 of the United States Code in order to authorize the Coast Guard to carry on certain oceanographic research.

The President in his letter to the President of the Senate dated March 29, 1961, relating to a national oceanographic program, stated that Coast Guard enabling legislation at present limits the extent to which the Coast Guard can engage in scientific research and he recommended that statutory limitations restricting participation by the Coast Guard in oceanographic research be removed. The President further stated that with oceanographic weather stations, deep sea thermometers, and other data collection devices, the Coast Guard can make a valuable contribution to the oceanographic program.

Consequently, the Department is wholeheartedly in favor of the objective of the bill to grant Coast Guard general authority to conduct oceanographic research. However, the primary duties of the Coast Guard are generally set forth in section 2 of title 14 of the United States Code. Hence, the Department feels that an amendment to that section would be the most appropriate method of accomplishing that objective. Therefore, the Department recommends that S. 1189 be revised to read as follows: "That section 2 of title 14, United States Code, is amended by inserting the words 'shall engage in oceanographic research on the high seas and in waters subject to the jurisdiction of the United States;' before the last clause of this section which reads 'and shall maintain a state of readiness to function as a specialized service in the Navy in time of war.'" If the proposed authority were provided in this manner, the use of Coast Guard facilities and cooperation with other agencies would then be authorized by existing sections 92, 93, and 141 of title 14 of the United States Code.

Subject to the amendment suggested above, the Department strongly urges the enactment of S. 1189.

The Bureau of the Budget has advised that the enactment of legislation as suggested above would be consistent with the administration's objectives.

Very truly yours,

A. GILMORE FLUES,
Acting Secretary of the Treasury.

THE WHITE HOUSE,
Washington, March 29, 1961.

Hon. LYNDON B. JOHNSON,
President of the United States Senate,
Washington, D.C.

MY DEAR MR. PRESIDENT: The seas around us, as I pointed out in my message to the Congress on February 23, represent one of our most important resources. If vigorously developed, this resource can be a source of great benefit to the Nation and to all mankind.

But it will require concerted action, purposefully directed, with vision and ingenuity. It will require the combined efforts of our scientists and institutions, both public and private, and the coordinated efforts of many Federal agencies. It will involve substantial investments in the early years for the construction and operation of ship and shore facilities for research and surveys, the development of new instruments for charting the seas and gathering data, and the training of new scientific manpower.

We are just at the threshold of our knowledge of the oceans. Already their military importance, their potential use for weather predictions, for food and for minerals are evident. Further research will undoubtedly disclose additional uses.

Knowledge of the oceans is more than a matter of curiosity. Our very survival may hinge upon it. Although understanding of our marine environment and maps of the ocean floor would afford to our military forces a demonstrable advantage, we have thus far neglected oceanography. We do not have adequate charts of more than 1 or 2 percent of the oceans.

The seas also offer a wealth of nutritional resources. They already are a principal source of protein. They can provide many times the current food supply if we but learn how to garner and husband this self-renewing larder. To meet the vast needs of an expanding population, the bounty of the sea must be made more available. Within two decades, our own Nation will require over a million more tons of seafood than we now harvest.

Mineral resources on land will ultimately reach their limits. But the oceans hold untapped sources of such basic minerals as salt, potassium and magnesium in virtually limitless quantities. We will be able to extract additional elements from sea water, such as manganese, nickel, cobalt and other elements known to abound on the ocean floor, as soon as the processes are developed to make it economically feasible.

To predict, and perhaps some day to control, changes in weather and climate is of the utmost importance to man everywhere. These changes are controlled to a large and yet unknown extent by what happens in the ocean. Ocean and atmosphere work together in a still mysterious way to determine our climate. Additional research is necessary to identify the facts in this interplay.

These are some of the reasons which compel us to embark upon a national effort in oceanography. I am therefore requesting funds for 1962 which will nearly double our Government's investment over 1961, and which will provide $23 million more for oceanography than what was recommended in the 1962 budget submitted earlier. A summary and comparison of the 1960, 1961, and 1962 budgets is contained in two tables which are enclosed with this letter.

1. SHIP CONSTRUCTION

The proposed program for 1962 includes $37 million for ship construction, an increase of $23 million over 1961. This will provide for 10 oceanographic vessels. Only two will replace existing ships. The others will be used to meet needs that have long existed in Federal agencies and other oceanographic institutions conducting research for the Government.

The present U.S. oceanographic fleet is composed of 27 research ships and 17 survey vessels. All but two were constructed prior to the end of World War II; many are over 30 years old. Only two of the ships were designed specifically for research purposes; the remainder has been converted from a variety of ships designed for other uses. Thus the success of the national oceanographic program will depend heavily on the construction of the new specially designed vessels proposed for 1962.

2. SHORE FACILITIES AND DATA CENTER

Shore facilities are urgently required to provide laboratory space for analysis and interpretation of data and to train new oceanographers. In oceanographic research about five scientists and technicians are required ashore for each scientist aboard ship.

For 1962, $10 million is being requested for laboratories and wharfside facilities. This represents a fivefold increase over 1961. It includes, for example, funds for a new Bureau of Commercial Fisheries laboratory to replace a 40-year old structure and additional laboratory space at universities and other oceanographic institutions.

An essential part of the Shore Establishment is the new National Oceanographic Data Center will begin its first full year of operation in 1962. This center will make available to the scientific community oceanographic data collected throughout the world.

3. BASIC AND APPLIED RESEARCH

The conduct of research is the central purpose of our whole national effort in oceanography. New ships and shore facilities are essential tools of scientific research, but it is the research itself that will yield new knowledge of the earth's "inner space," and new uses of the sea. The proposed program includes $41 million for basic and applied research in oceanography. This is an increase of $9 million over the 1961 level.

Basic research is the cornerstone on which the successful use of the seas must rest. Progress here is largely dependent on the work of scientists at many universities and laboratories throughout the United States and on ships at sea. Their investigations cover all aspects of the marine environment, the motion and composition of ocean waters, the evolution and distribution of marine plants and animals, the shape and composition of the ocean bottom, and many other geophysical and biological problems. Of timely significance is the attempt to penetrate to the earth's mantle to better our understanding of the origin and history of our planet. This undertaking, known as Project Mohole, involves the development of new drilling methods that can be used in the deep seas. This project has recently resulted in a spectacular achievement. Samples from nearly a thousand feet beneath the sea floor were obtained by drilling in 3,000 feet of water.

Considerable attention will also be given to applied problems in the marine sciences. Oceanographers will be studying such problems as sound propagation in water, the effects of changes in ocean conditions on the movement of ships, weather forecasting and fisheries management. Methods of predicting changes in ocean conditions also are being developed. Eventually they may lead to maps of "weather within the sea" much like the atmospheric weather maps of today.

Many advances are being made in methods of exploring the seas. Oceanographers are now able to descend to the great depths in bathyscaphs. New electronic equipment will allow them to probe the ocean and to "see" with sound pulses what before has been opaque. Using these new techniques, our scientists already have discovered vast currents below the ocean surface a thousand times larger than the flow of the Mississippi.

4. TRAINING OF OCEANOGRAPHERS

The most important part of our long-range program in oceanography is the training of young scientists. Scientific manpower of every sort will be needed—technicians, college graduates, and postgraduate researchers—and they must be trained in many scientific disciplines. This training should go hand in hand with the conduct of research at universities and other oceanographic institutions. By their support of these institutions, the programs of the National Science Foundation, the Office of Naval Research, and the Department of Health, Education, and Welfare will be of major importance to an expanding program in oceanography; for they can result in the education of new young scientists as well as in the production of new knowledge. In the coming year, these agencies are undertaking to increase the number of fellowship awards and graduate student research contracts, and they also will encourage the development of new university programs in oceanography.

5. OCEAN SURVEYS

Worldwide surveys of the oceans—their properties, their contents and boundaries—are needed to make charts and maps for use of scientists in their research programs and for a variety of commercial and defense applications. The U.S. ocean survey program of fiscal year 1962 is being increased within the limits of ships available for this purpose. I am requesting additional funds to allow the Coast and Geodetic Survey to extend the operating season of its existing ships, thus making the maximum use of limited ship resources. As already mentioned, funds are included for a new survey ship which will increase our deep-sea survey capability.

6. INTERNATIONAL COOPERATION

Oceanography is a natural area of opportunity for extensive international cooperation. Indeed, systematic surveys and research in all the oceans of the world represent tasks of such formidable magnitude that international sharing of the work is a necessity.

Our present maps of the oceans are comparable in accuracy and detail to maps of the land areas of the earth in the early part of the 18th century. Precise methods of measuring ocean depths have become available during the last 10 years, and these, when combined with new developments in navigation, should make possible for the first time modern maps of the topography of the entire sea floor. An accurate mapping of the oceans will require international cooperation in ship operations and in establishing a worldwide system of navigation. In these endeavors the United States can play a leading part.

This year an Intergovernmental Oceanographic Commission is being established under UNESCO to provide a means whereby interested countries can cooperate in research and in making surveys and maps of the deep sea floor, the ocean waters, and their contained organisms. Membership on the Commission is open to all countries of the U.N. family that desire to cooperate in oceanography. the United States intends to participate fully in the activities of the Commission.

The United States also will participate in the International Indian Ocean Expedition. Many nations, including the Soviet Union, are cooperating in this expedition under the nongovernmental sponsorship of the International Council of Scientific Unions. Over a quarter of the world's people live in the countries surrounding the Indian Ocean. If more can be learned of the Indian Ocean's extensive food resources, these nations can be helped to develop and expand their fishing industries as part of their general economic development.

7. THE COAST GUARD

At present, the Coast Guard enabling legislation limits the extent to which the Coast Guard can engage in scientific research. Only the International Ice Patrol is authorized to make such studies. I recommend that the statutory limitations restricting the participation by the Coast Guard in oceanographic research be removed. With ocean weather stations, deep-sea thermometers, and other data collection devices, our Coast Guard can make a valuable contribution to the oceanographic program.

CONCLUSION

Knowledge and understanding of the oceans promise to assume greater and greater importance in the future. This is not a 1-year program—or even a 10-year program. It is the first step in a continuing effort to acquire and apply the information about a part of our world that will ultimately determine conditions of life in the rest of the world. The opportunities are there. A vigorous program will capture those opportunities.

Sincerely,

JOHN F. KENNEDY.

NATIONAL OCEANOGRAPHIC PROGRAM, BUDGET SUMMARIES

TABLE I.—*Summary by Federal agency*

[Thousands of dollars]

	Actual, fiscal year 1960	Estimate, fiscal year 1961	Estimate, fiscal year 1962
Defense	23,003	22,729	32,837
Commerce	6,202	11,389	24,691
Interior	6,723	8,704	15,472
National Science Foundation	7,833	9,148	19,607
Atomic Energy Commission	1,708	2,207	3,610
Health, Education, and Welfare	340	698	1,150
Treasury	134	134	134
Total	45,943	55,009	97,501

TABLE II.—*Summary by function*

[Thousands of dollars]

	Actual, fiscal year 1960	Estimate, fiscal year 1961	Estimate, fiscal year 1962
Research	26,577	31,883	40,794
Ship construction	13,533	13,975	37,050
Surveys	4,168	7,117	8,725
Facilities	1,370	1,768	10,422
Data center	295	266	510
Total	45,943	55,009	97,501

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